



ICOM

SERVICE MANUAL

IC-28A/E/H

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ICOM INCORPORATED

FOREWORD

Thank you for selecting ICOM's versatile **IC-28A/E/H**, one of the finest FM mobile transceivers on the market today.

Sophisticated in design, yet light, compact, and easy to operate, the **IC-28A/E/H** benefits from the latest in ICOM engineering techniques and from ICOM's established leadership in the communications field.



The picture shows the IC-28A version.

ASSISTANCE

Four separate versions of the **IC-28A/E/H** have been designed for use in the U.S.A., Europe, Australia, and in Spain and Italy. This service manual covers every version. When using the manual each model can be referred to by the following assigned version numbers:

- #01 U.S.A. version
- #03 EUROPE version
- #04 AUSTRALIA version
- #05 SPAIN, ITALY versions

If you require assistance or information regarding the operation and capabilities of the **IC-28A/E/H**, please contact your nearest authorized ICOM Dealer or ICOM Service Center.

TABLE OF CONTENTS

SECTION 1 SPECIFICATIONS	1 – 1 ~ 2
1 - 1 GENERAL	1 – 1
1 - 2 TRANSMITTER	1 – 1
1 - 3 RECEIVER	1 – 2
SECTION 2 OUTSIDE AND INSIDE VIEWS	2 – 1 ~ 4
2 - 1 FRONT PANEL	2 – 1
2 - 2 DISPLAY	2 – 2
2 - 3 REAR PANEL	2 – 2
2 - 4 MAIN UNIT	2 – 3
2 - 5 EF UNIT	2 – 3
2 - 6 RX UNIT	2 – 4
SECTION 3 BLOCK DIAGRAM	3 – 1
SECTION 4 CIRCUIT DESCRIPTION	4 – 1 ~ 6
4 - 1 RECEIVER CIRCUITS	4 – 1
4 - 2 TRANSMITTER CIRCUITS	4 – 2
4 - 3 PLL CIRCUITS	4 – 2
4 - 4 LOGIC CIRCUITS	4 – 3
SECTION 5 DISASSEMBLY AND ASSEMBLY DIAGRAMS	5 – 1 ~ 6
5 - 1 FRONT PANEL DISASSEMBLY	5 – 1
5 - 2 FRAME DISASSEMBLY	5 – 2
5 - 3 MAIN UNIT CONNECTOR ASSEMBLY (IC-28A/E VERSIONS)	5 – 3
5 - 4 RX UNIT CONNECTOR ASSEMBLY (IC-28A/E VERSIONS)	5 – 4
5 - 5 MAIN UNIT CONNECTOR ASSEMBLY (IC-28H VERSIONS)	5 – 5
5 - 6 RX UNIT CONNECTOR ASSEMBLY (IC-28H VERSIONS)	5 – 6
SECTION 6 MAINTENANCE AND ADJUSTMENT	6 – 1 ~ 12
6 - 1 PREPARATION BEFORE SERVICING	6 – 1
6 - 2 PLL ADJUSTMENT	6 – 1
6 - 3 TRANSMITTER ADJUSTMENT	6 – 3
6 - 4 RECEIVER ADJUSTMENT	6 – 7
6 - 5 RX LEVEL DIATRAM	6 – 11
6 - 6 TX LEVEL DIAGRAM	6 – 12
SECTION 7 BOARD LAYOUTS	7 – 1 ~ 4
7 - 1 EF UNIT	7 – 1
7 - 2 MAIN UNIT (IC-28A/E VERSIONS)	7 – 2
7 - 3 MAIN UNIT (IC-28H VERSIONS)	7 – 3
7 - 4 RX UNIT	7 – 4
SECTION 8 VOLTAGE/CIRCUIT DIAGRAMS	8 – 1 ~ 5
8 - 1 EF UNIT WIRING DIAGRAM	8 – 1
8 - 2 EF UNIT	8 – 2
8 - 3 MAIN UNIT (IC-28A/E VERSIONS)	8 – 3
8 - 4 MAIN UNIT (IC-28H VERSIONS)	8 – 4
8 - 5 RX UNIT	8 – 5
SECTION 9 TROUBLESHOOTING	9 – 1
SECTION 10 IC RATINGS	10 – 1 ~ 5
10 - 1 LINEAR ICs	10 – 1
10 - 2 LOGIC ICs	10 – 3

SECTION 11 PARTS LIST	11 – 1 ~ 7
11 - 1 EF UNIT	11 – 1
11 - 2 MAIN UNIT	11 – 2
11 - 3 RX UNIT	11 – 5
SECTION 12 OPTIONAL UNITS	12 – 1 ~ 6
12 - 1 UT-28, UT-29 OPTIONS	12 – 1
12 - 2 UT-28, UT-29 BOARD LAYOUTS	12 – 2
12 - 3 UT-28 VOLTAGE/CIRCUIT DIAGRAM	12 – 3
12 - 4 UT-29 VOLTAGE/CIRCUIT DIAGRAM	12 – 4
12 - 5 UT-28, UT-29 PARTS LIST	12 – 5
12 - 6 OTHER OPTIONAL UNITS	12 – 6
SECTION 13 SCHEMATIC DIAGRAM	SEPARATE

SECTION 1 SPECIFICATIONS

1 - 1 GENERAL

Frequency coverage

MODEL	GUARANTEED RANGE	OPERATIONAL RANGE	
	TRANSCEIVER	RECEIVER	TRANSMITTER
IC-28A U.S.A. version	144.00 ~ 148.00	138.00 ~ 174.00	140.10 ~ 150.00
IC-28E Europe version	144.00 ~ 146.00	144.00 ~ 146.00	144.00 ~ 146.00
IC-28A Australia version	144.00 ~ 148.00	144.00 ~ 148.00	144.00 ~ 148.00
IC-28E Spain, Italy Versions	144.00 ~ 148.00	140.00 ~ 150.00	140.00 ~ 150.00

NOTE: Ranges are identical for the IC-28H model.

Frequency resolution

: U.S.A., Australia versions 5, 10, 15, 20 or 25kHz (programmable)
Europe, Italy, Spain versions 12.5 or 25kHz (programmable)

Frequency control

: CPU based 5kHz (or 6.25kHz) step digital PLL synthesizer
Simplex and semi-duplex capability (programmable offset)

Memory channels

: 21 channels

Usable temperature range

: -10°C ~ +60°C (+14°F ~ +140°F)

Power supply requirement

: 13.8V DC±15% (negative ground)

: AC power supply is available for AC operation.

Current drain (at 13.8V DC)

(IC-28A/E versions)

: Transmit

HIGH (25W)	Approx.	6.0A
LOW (5W)	Approx.	3.0A

: Receive

Max. audio output	Approx.	800mA
Squelched	Approx.	450mA

(IC-28H version)

: Transmit

HIGH (45W)	Maximum	9.5A
LOW (5W)	Approx.	3.5A

: Receive

Max. audio output	Approx.	800mA
Squelched	Approx.	450mA

Antenna impedance

: 50 ohms unbalanced

Dimensions

: 140(140)mm(W) x 50(50)mm(H) x 133(148.5)mm(D)

: Bracketed values include projections

Weight

: 0.95kg (IC-28A/E versions)

: 1.2kg (IC-28H version)

1 - 2 TRANSMITTER

(IC-28A/E versions)

Output power

: HIGH 25W LOW 5W

Emission mode

: 16K0F3E

Modulation system

: Variable reactance frequency modulation

Max. frequency deviation

: ±5.0kHz

Spurious emissions

: More than 60dB below carrier

Microphone

: 600 ohm electret condenser with Push-To-Talk and scanning switches
(Europe, Spain, and Italy versions include a 1750Hz TONE BURST SWITCH)

(IC-28H version)

Output power	: HIGH 45W LOW 5W
Emission mode	: 16K0F3E (16K0F2D: When operating with an optional UT-28)
Modulation system	: Variable reactance frequency modulation
Max. frequency deviation	: $\pm 5.0\text{kHz}$
Spurious emission	: More than 60dB below carrier
Microphone	: 600 ohm electret condenser with Push-To-Talk and scanning switches (Europe, Spain, and Italy versions include a 1750Hz TONE BURST SWITCH)

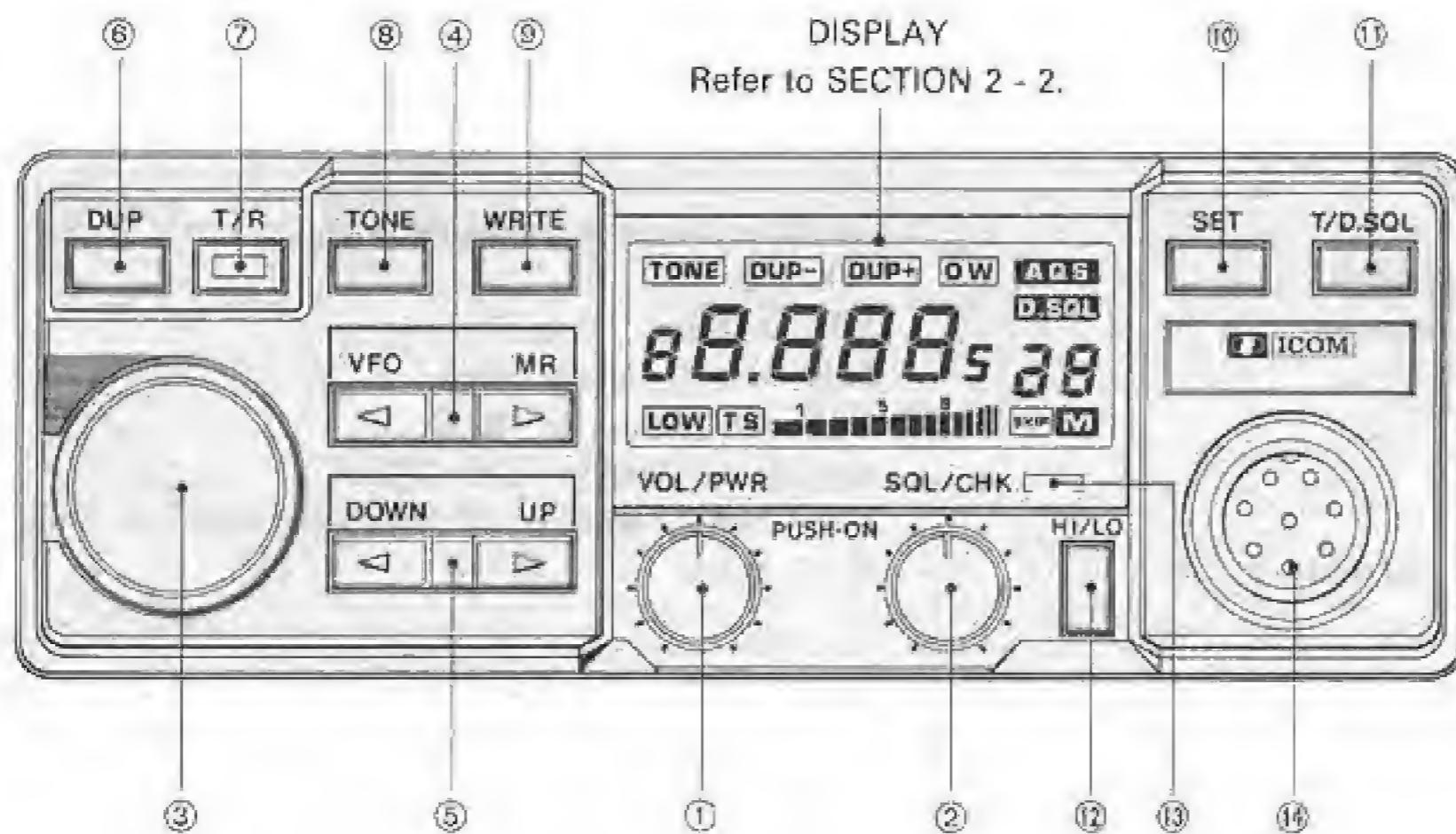
1 - 3 RECEIVER

Receive system	: Double-conversion superheterodyne
Modulation acceptance	: 16K0F3E
Intermediate frequencies	: 1st 17.2MHz 2nd 455kHz
Selectivity	: More than 12.5kHz at -6dB Less than 25.0kHz at -60dB
Sensitivity	: Less than $0.18\mu\text{V}$ for 12dB SINAD
Audio output	: More than 2.4 watts at 10% distortion with 8 ohm load
Audio output impedance	: 4 ~ 8 ohms

All stated specifications are approximate and subject to change without notice or obligation.

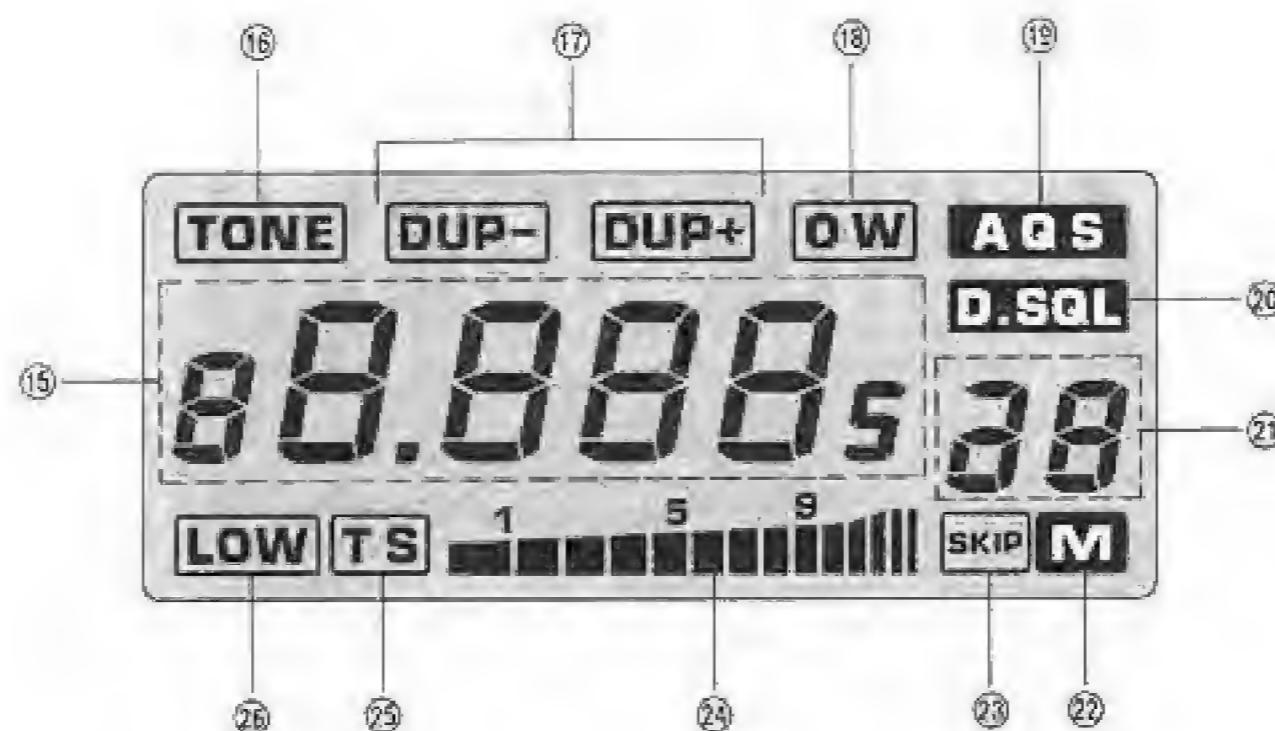
SECTION 2 OUTSIDE AND INSIDE VIEWS

2 - 1 FRONT PANEL



- ① VOLUME CONTROL/POWER SWITCH [VOL/PWR]
- ② SQUELCH CONTROL/CHECK SWITCH [SQL/CHK]
- ③ TUNING CONTROL
- ④ VFO/MEMORY READ SWITCH [VFO/MR]
- ⑤ DOWN/UP SWITCH [DOWN/UP]
- ⑥ DUPLEX SWITCH [DUP]
- ⑦ TRANSMIT/RECEIVE INDICATOR [T/R]
- ⑧ TONE SWITCH [TONE] (U.S.A. version)
CALL SWITCH [CALL] (Australia, Europe, Spain, Italy versions)
- ⑨ WRITE SWITCH [WRITE]
- ⑩ SET SWITCH [SET]
- ⑪ TONE SQUELCH SWITCH/DIGITAL SQUELCH SWITCH [T/D. SQL]
- ⑫ HIGH/LOW SWITCH [HI/LO]
- ⑬ DISPLAY DIMMER SENSOR
- ⑭ MIC CONNECTOR

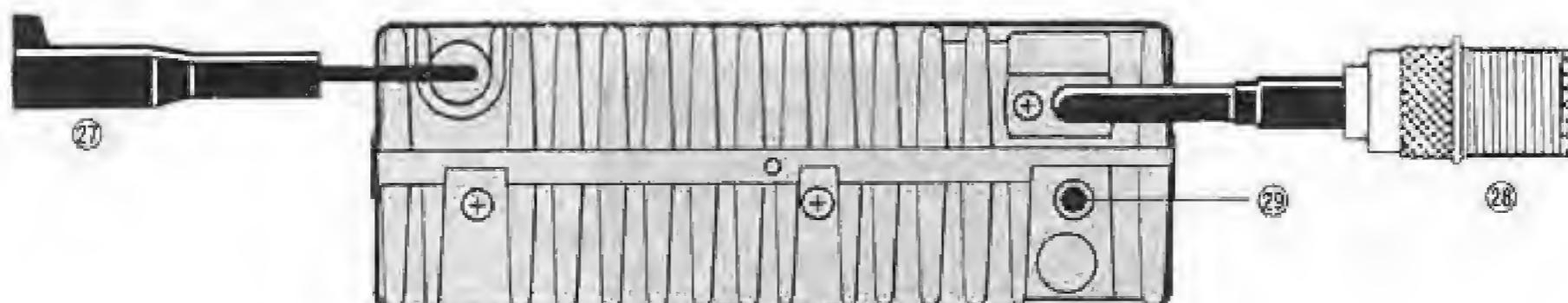
2 - 2 DISPLAY



- ㉗ FREQUENCY
- ㉘ SUBAUDIBLE TONE INDICATOR "TONE"
- ㉙ DUPLEX MODE INDICATORS "DUP-, DUP+"
- ㉚ OFFSET WRITE INDICATOR "OW"
- ㉛ GROUP CODE INDICATOR "AQS"
- ㉜ SQUELCH SYSTEM INDICATOR "D. SQL"
- ㉝ MEMORY CHANNEL NUMBER
- ㉞ MEMORY MODE INDICATOR "M"
- ㉟ MEMORY CHANNEL SKIP INDICATOR "SKIP"
- ㉟ S/RF INDICATOR
- ㉟ TUNING STEP INDICATOR "TS"
- ㉟ OUTPUT POWER INDICATOR "LOW"

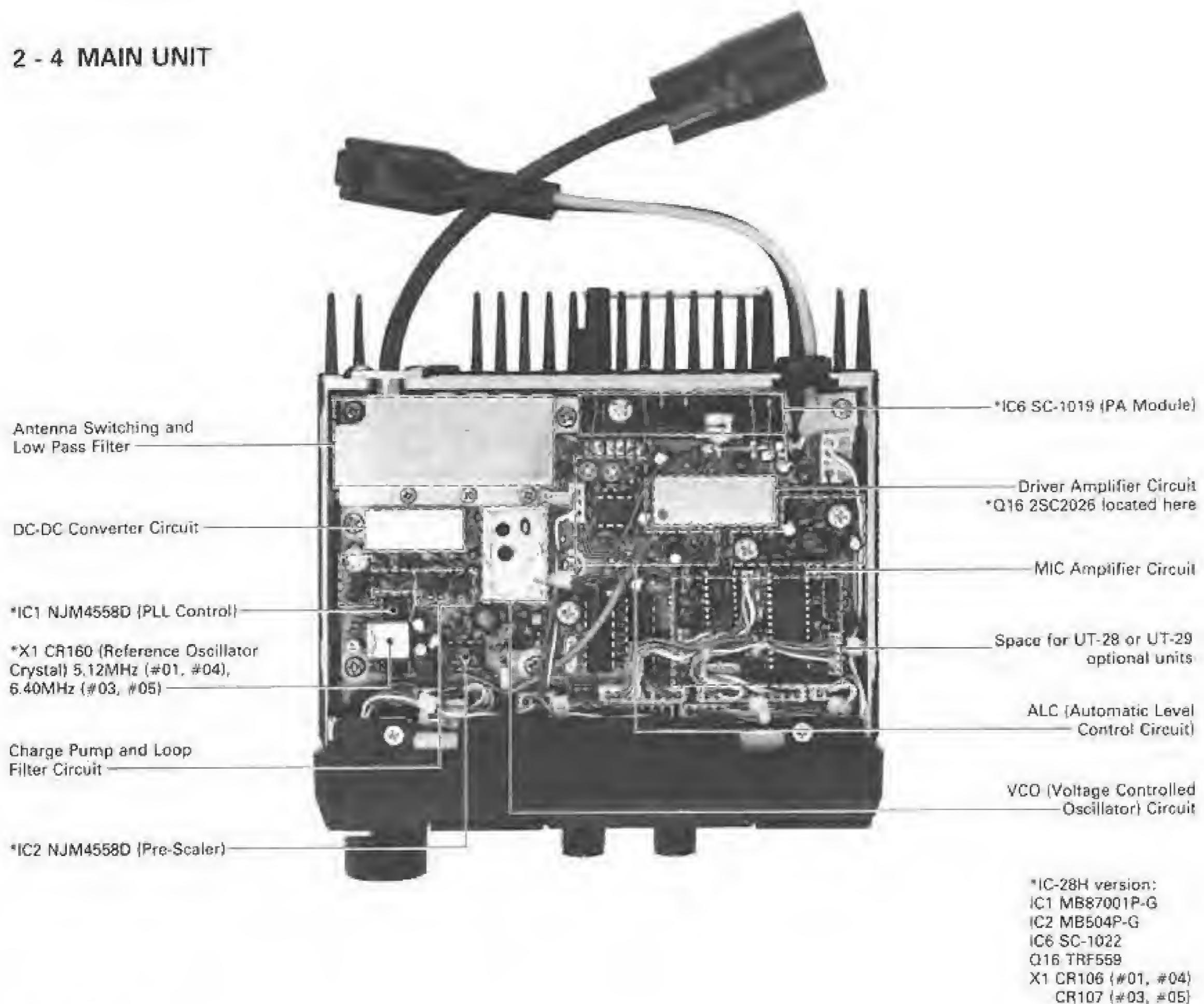
AQS refers to Amateur Quinmatic System which includes digital code squelch as one feature. The digital code squelch used in AQS is not compatible with some other commercially available digital squelch systems.

2 - 3 REAR PANEL

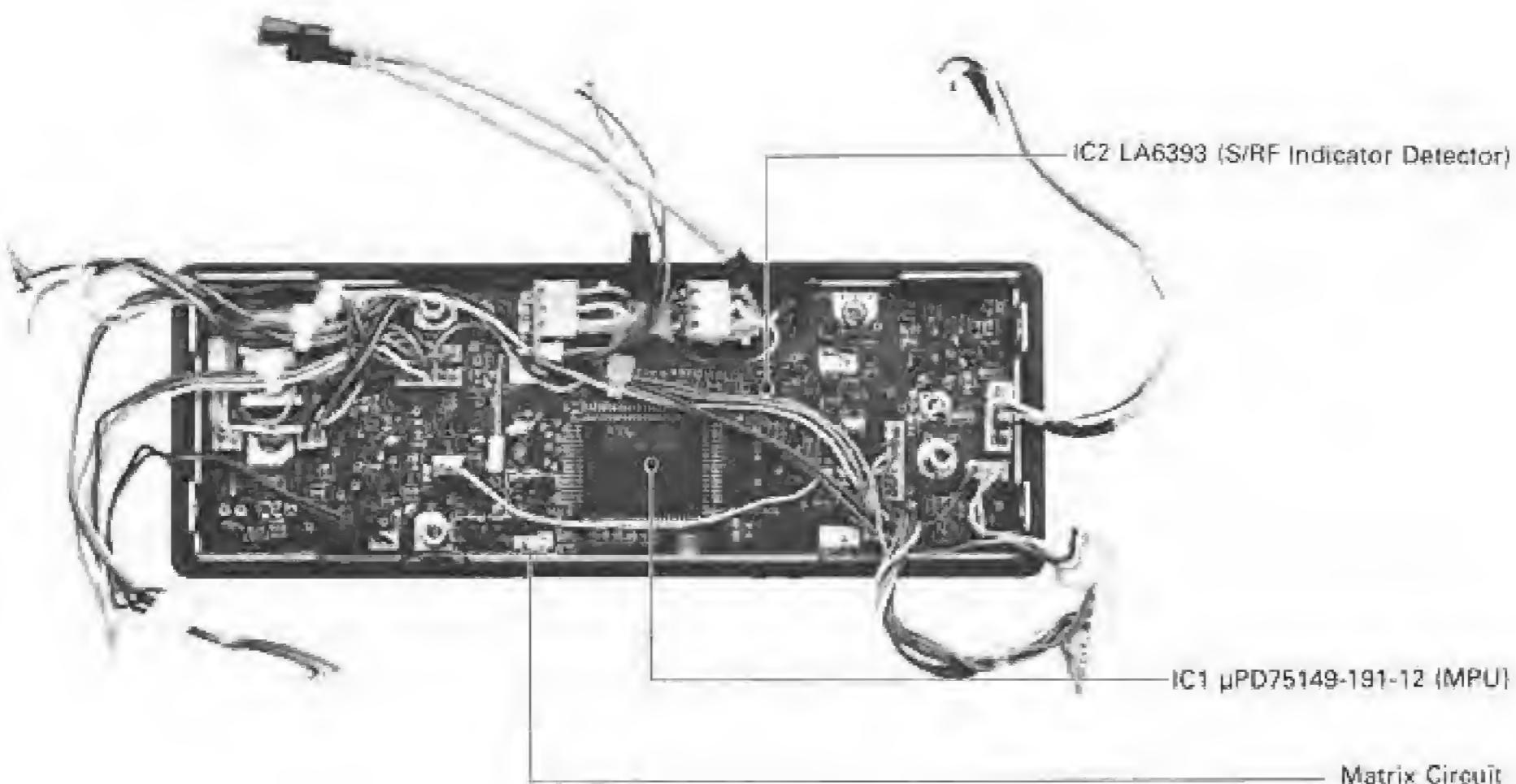


- ㉗ POWER CONNECTOR
- ㉘ ANTENNA CONNECTOR
- ㉙ EXTERNAL SPEAKER JACK

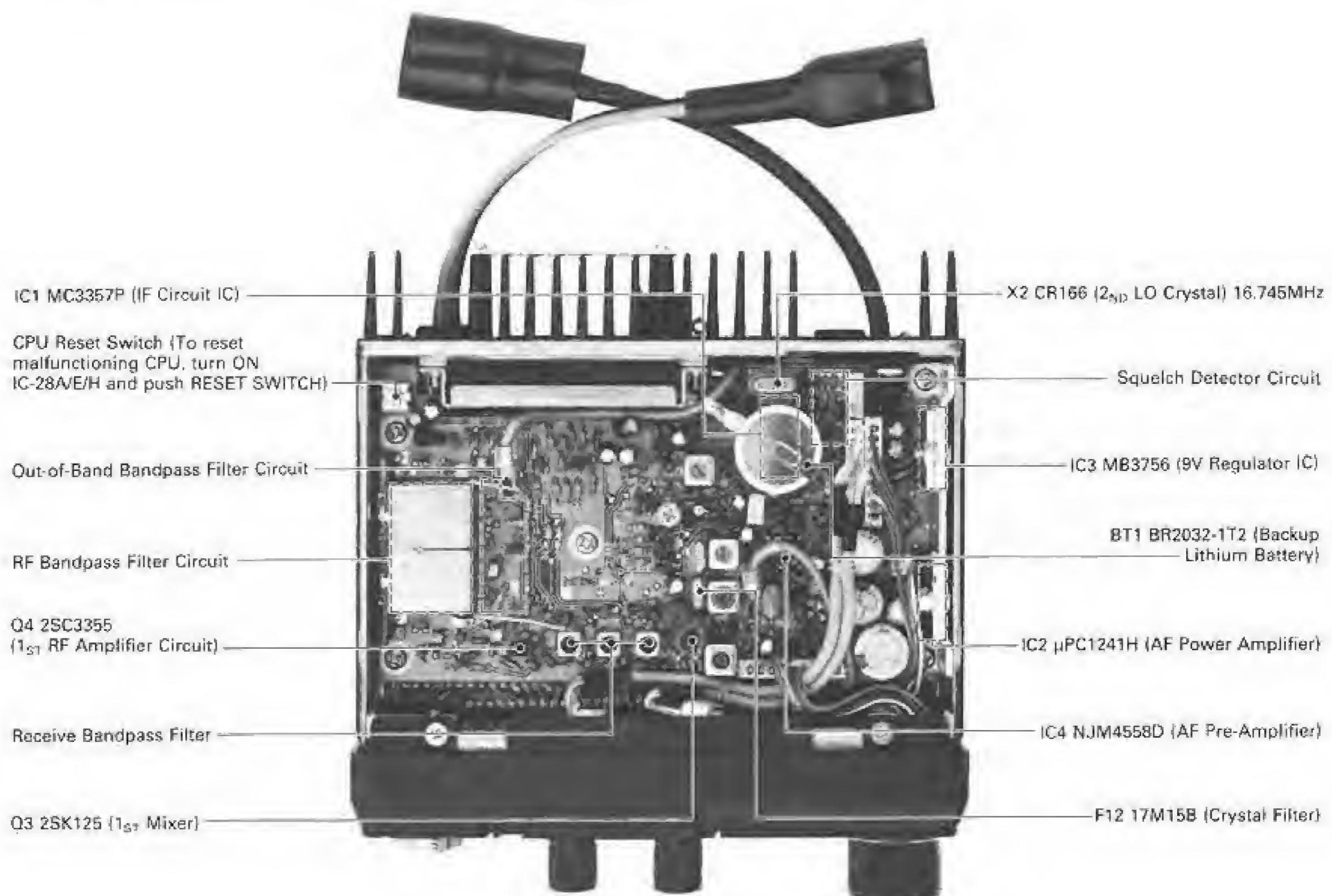
2 - 4 MAIN UNIT



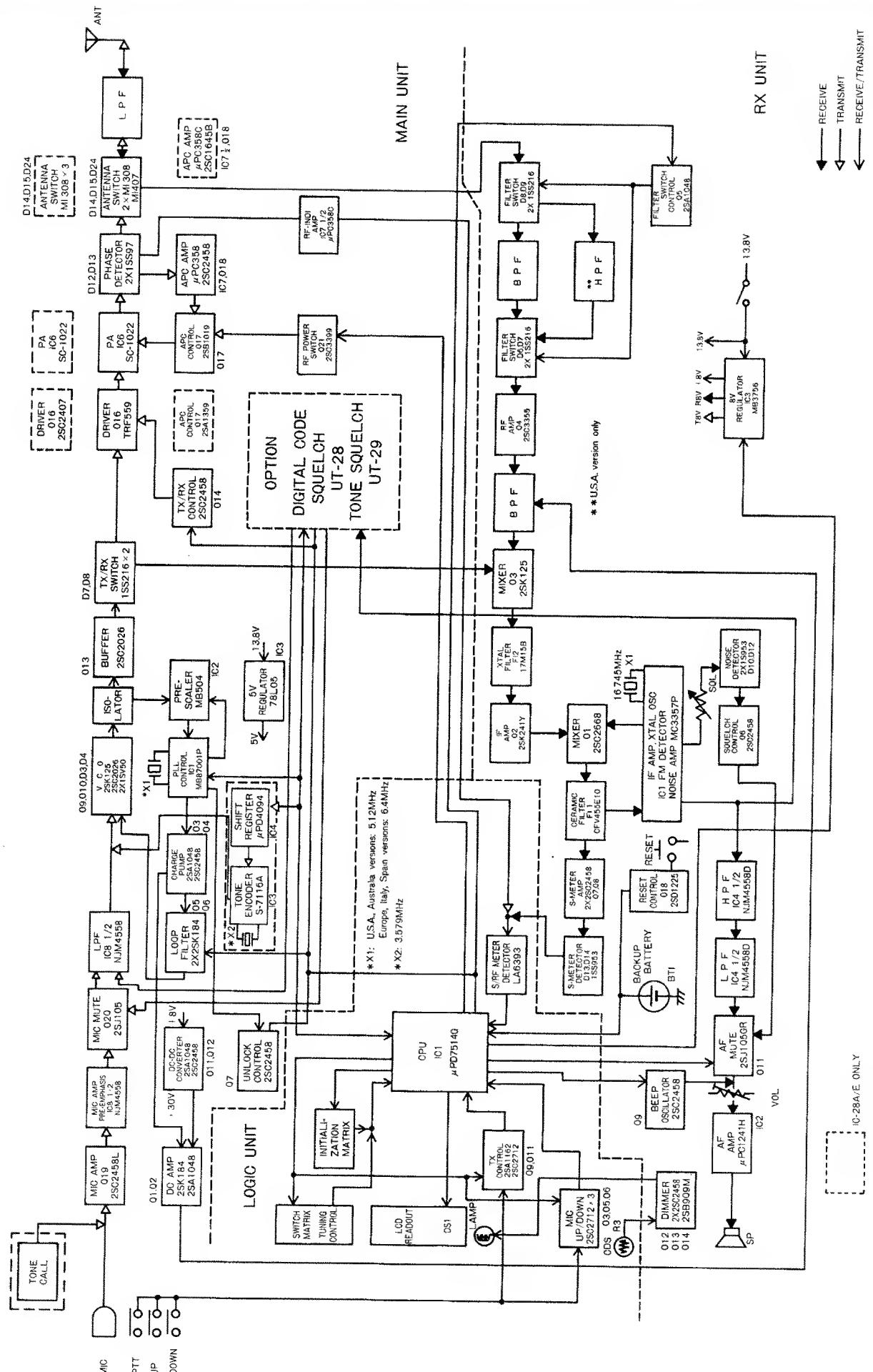
2 - 5 EF UNIT



2 - 6 RX UNIT



SECTION 3 BLOCK DIAGRAM



SECTION 4 CIRCUIT DESCRIPTION

4 - 1 RECEIVER CIRCUITS

4 - 1 - 1 RF CIRCUIT

Signals from the antenna are fed to the RX UNIT through a constant K pie-type filter on the MAIN UNIT. In the amateur band an RF circuit having good intermodulation characteristics is created by using a bandpass filter (consisting of L11 and L10) that eliminates nearby amateur band signals. When operating out of the amateur band the RF circuit has a broad bandpass filter which uses a high pass filter (consisting of C48, L13, C47) and a constant K pie-type filter. The RF circuit is then free of variance on any frequency from 138 ~ 174MHz.

Switching between bandpass filters in and out of the amateur band is controlled by a signal from the LOGIC UNIT. This signal activates Q5 which turns ON and OFF a quarter-wave diode switch that is connected to the input and output of the bandpass filter.

Signals amplified by Q4 are fed to three-stage variable resonators consisting of coils L8, L7 and L6, and diodes D4, D3, and D2 to eliminate unwanted out-of-frequency signals and to obtain good receiver selectivity.

The control voltage for varactor diodes D4, D3 and D2 is supplied by the VCO UNIT through a buffer amplifier. This amplifier requires high voltage, so a DC-DC converter circuit is used to supply 30V DC to the buffer amplifier.

4 - 1 - 2 IF CIRCUIT

Signals from the BPF are passed into Q3 and are mixed with a 1st LO signal to convert the IF signal to 17.2MHz. The 1st LO signal is fed into R14 on the RX UNIT by applying R8V to a diode switch on the MAIN UNIT.

The 1st IF signal mixed by Q3 is fed to a matching circuit consisting of L3 and is fed to FI2, a high-shaped factor crystal filter designed to accept only the object signal and to eliminate any unwanted signals.

The 1st IF signal passed through the filter is fed to a matching circuit consisting of L2, and is amplified by Q2, the 1st IF amplifier. The amplified signal is fed to Q1, the 2nd mixer circuit, to obtain the 2nd IF frequency (455kHz) with a 2nd LO signal generated by an oscillator circuit in IC1 and crystal X2.

The 2nd IF signal is fed to a high-performance ceramic filter, FI1, to eliminate unwanted signals and is amplified by a limiter amplifier in IC1. The amplified signal is fed to an FM detector circuit in IC1 using quadrature detection to get audio signals. This IF circuit creates a non-adjustment circuit using a phase-delay element with an X1 ceramic discriminator.

4 - 1 - 3 AF CIRCUITS

Audio signals from IC1 are amplified by a noise amplifier circuit in IC1 through the SQUELCH CONTROL on the front panel. A noise detector circuit consisting of D10 and D12 detects noise components and controls Q6 to receive the squelch control signal. This control signal is applied to Q10, turning ON and OFF Q11, the analog switch circuit, and to Q17. This action controls the IC2 AF amplifier which emits no audio output, including noise output, when no signal is received.

The audio signal from IC1 is fed to IC4 for deemphasis as well as for subaudible tone audio reduction from the speaker when the TONE SQUELCH function is being used. This audio signal is applied to the IC2 AF amplifier through the Q11 analog switch circuit and the VOLUME CONTROL on the front panel. The signal is amplified by IC2 and drives the internal or external speaker.

Q11 functions as a muting circuit using an analog switch to block the audio signal to IC2. An AF MUTE signal is obtained by the SQUELCH CONTROL or when the transceiver is in transmit mode. Q17 blocks leakage of the audio signal on the pin 1 line of IC2 when Q11 is activated.

When the beep oscillator is activated, Q16 controls Q17 and the beep signal is applied to IC2. If SWITCHES such as [DUP], [TONE], [WRITE], [VFO], [MR] and [SET] on the front panel are pushed, a parallel R-type phase oscillator using Q9 is activated by a signal from the CPU, emitting a beep sound. At this time, Q11 is activated and only the beep sound is emitted from the speaker.

4 - 1 - 4 S-METER CIRCUIT

S-meter signals are created by 2nd IF signals which are passed through FI1 and amplified by Q7 and Q8, the S-meter amplifier circuit. The 2nd IF signals are then fed to D13 and D14 where they are rectified, obtaining DC signals for the S-meter signal. The S-meter signal is then added to the RF-meter signal and this signal drives the bar indicator on the FREQUENCY DISPLAY through the LCD driver in the CPU.

4 - 1 - 5 AUTOMATIC DIMMER CIRCUIT

This circuit consists of Q12, Q13, Q14 on the RX UNIT and a photo sensor, R3 (CDS) on the EF UNIT. The CDS alters DISPLAY brightness according to variation of current. The current is amplified by Q14 and drives Q12 and Q13. The brightness of the FREQUENCY DISPLAY changes continuously via C113.

4 - 1 - 6 VOLTAGE REGULATOR CIRCUITS

The 13.8V line which passes through the POWER SWITCH on the front panel is applied to IC3 on the RX UNIT. IC3 is a voltage regulator with a selector switch IC chip for applying a constant 8V, R8V during receiving, and T8V during transmitting.

4 - 1 - 7 CPU RESET CIRCUIT

S1 and Q19 reset the CPU. If the CPU should malfunction, push the RESET SWITCH to reset it (See page 2 - 4 for the RESET SWITCH location on the RX UNIT). At this time, the CPU is initialized. Q18 prevents the transceiver from reverting to transmit mode when the CPU is being reset. The reset function only operates when the transceiver is ON.

4 - 2 TRANSMITTER CIRCUIT

4 - 2 - 1 MIC AMPLIFIER CIRCUIT

Audio signals from the microphone are fed into Q19, the first mic amplifier circuit, on the MAIN UNIT. After passing through this circuit, the signals are fed into IC8(A), the limiter amplifier circuit. This circuit has preemphasis characteristics between 300Hz and 3kHz with 6dB/octave.

Output signals from the limiter amplifier pass through Q20, the mic mute circuit, and are fed into IC8(B), the active low-pass filter circuit. The rectangular waveform of the limiter amplifier output contains many harmonics. Harmonics which are 3kHz or higher are eliminated by IC8(B).

These filtered signals are applied to the VCO to modulate the frequency and produce an FM signal. R100 is a variable resistor for adjusting deviation.

4 - 2 - 2 BUFFER AND DRIVE CIRCUITS

Signals generated at the VCO circuit are buffered at Q10, and passed through an isolating circuit consisting of L6, C24 and R30 to R32. After passing through the isolating circuit, signals are buffered and amplified at Q13 and applied to the driver amplifier circuit through switching circuit, D7 and D8. The driver amplifies the signal to a suitable level for the power amplifier.

4 - 2 - 3 POWER AMPLIFIER CIRCUIT

Output signals from the driver amplifier are fed into the power amplifier module, IC6, and output 25 watts (A/E version) or 45 watts (H version). The output signal of IC1 is applied to the ANTENNA CONNECTOR through the T/R switching circuit, D14, and the low pass filter.

4 - 2 - 4 ALC (Automatic Level Control) and RF POWER METER CIRCUITS

The output voltage level of the ALC detector circuit (D12, D13 and L14) is a minimum value when the antenna impedance is matched at 50 ohms. However, when the antenna impedance is in a mismatched condition, the detector voltage becomes higher than it would be if the antenna were matched.

The detector voltage is applied to the APC amplifier circuit, IC7(A). Output of IC7(A) controls the Q18 bias voltage, which in turn controls the total gain of the power amplifier (IC6) through Q17. R71 is the HIGH Power adjustment point while R72 is the LOW Power adjustment point. Both variable resistors control the amp gain of the APC Amplifier, IC7(A).

The detector voltage is also used for the RF meter. This voltage is applied to pin 5 of IC7(B), is amplified, and then is applied to IC2, the S/RF meter detector circuit, on the EF UNIT.

4 - 3 PLL CIRCUITS

4 - 3 - 1 DUAL MODULUS PRESCALER

The PLL is designed in a way that allows the desired frequency to be generated directly by the VCO, adopting a dual modulus prescaler system. The PLL consists of a prescaler (IC2) and PLL IC (IC1). It is fed "divided by N-data" from the MPU which determines the operating frequency.

N-data is determined by dividing the desired frequency by the reference frequency. The desired frequency is the transmit frequency in the transmit mode and the first local oscillator frequency in the receive mode.

$$N = \frac{\text{Desired frequency}}{\text{Reference frequency}}$$

A reference frequency of 5kHz (#01, #04) or 12.5kHz (#03, #05) is acquired by X1 and the divider inside IC1. A signal from the VCO that is buffer amplified at Q10 is fed into IC2 and divided N-times through the local oscillator switching circuit (D7, D8). The divided signal at IC2 is applied to IC1 and phase detected, resulting in lock voltages being output from pins 9 and 10. Output voltages are applied to varactor diodes D3 and D4 to control the VCO frequency through the charge pump and the loop filter. Due to a no-multiplying mixing circuitry, the circuit constitution is simple and reduces spuriousness.

4 - 3 - 2 LOOP FILTER CIRCUIT

Output from pins 9 and 10 of IC1 is fed into a charge pump (Q3 and Q4) and is then applied to a lag lead-type loop filter (R6, R11, R13, C1 ~ C4).

The PLL time constant switching circuit (Q5, Q6) reduces the resistance of R6 to shorten the PLL lock up time. When the frequency or transmit/receive mode is being changed, pin 7 of IC1 is at "LOW", Q7 is "OPEN", and Q5 and Q6 are activated.

To create wide-band oscillation characteristics in the VCO, a high voltage is applied to the charge pump. Q11 and Q12 comprise a DC-DC converter circuit which generates approximately 30V.

4 - 3 - 3 VCO CIRCUIT

The VCO, Q9, employs a Hartley Oscillator Circuit. This oscillator circuit has no shift circuit, so lock voltages which come from N-data control the entire frequency range. An output signal from the VCO is buffer amplified at Q10 and passes through the isolation circuit, LB.

4 - 4 LOGIC CIRCUITS

Logic circuits are installed in the EF UNIT. The EF UNIT is located behind the front panel and controls receiver and transmitter sections as well as all switch functions on the front panel.

4 - 4 - 1 CPU PORT ALLOCATIONS

PORT NUMBER	DESCRIPTION
P00	Interrupt input. Processor enters STOP mode.
P01	Outputs serial CK signals for PLL, tone encoder and optional UT-28 or UT-29.
P02	Outputs serial DATA signals for PLL, tone encoder and optional UT-28 or UT-29.
P03	Operating frequency range of each version expands when this port is "HIGH".
P10 ~ P13	Input ports for the matrix circuit. Refer to page 4 - 4 for explanation of the matrix circuit.
P20	Output port for a strobe signal of the PLL N-data.
P21	Output port for a strobe signal of the built-in CTCSS encoder N-data.
P22	No function.
P30	This port becomes "HIGH" when a beep sound is emitted.
P31	This port becomes "LOW" for the SEND line when the transceiver is in the transmit mode.
P32	This port becomes "LOW" when low power output is selected.
P33	This port becomes "HIGH" when the Digital Code Squelch is turned ON.
P40	This port is for LCD control and becomes "HIGH" when the transceiver is turned OFF.
P41 ~ P53	These ports are for matrix output.
P60	This is a data input port for the S-INDICATOR and RF-INDICATOR. Refer to SECTION 4 - 4 - 3 for further information.
P61	This port outputs the RESET signal for the sub-CPU, and becomes "HIGH" for about 40μsec when the transceiver is initialized.
P62	This port becomes "HIGH" if the displayed frequency is out of band.
P63	This port becomes "HIGH" when AQS commands are sent to the sub-CPU in the AQS system.
P70	No function.
P71 ~ P73	These are data output ports for the S-INDICATOR and RF-INDICATOR. Refer to SECTION 4-4-3 for further information.
INT1	This is an input port for the Data Transmit Ready signal during communication with the sub-CPU for the AQS system, and is also an input port for the Group Number Verification signal when port P33 is "HIGH".

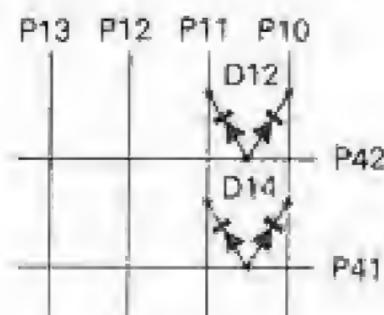
The EF UNIT includes a one-chip microcomputer CPU, NEC μPD7514G. This chip contains a 4-bit parallel processing ALU, an ROM, RAM, I/O ports, 8-bit serial interface, 8-bit programmable timer/event counter, and LCD controller/driver. It operates as an independent unit.

The following explanations are CPU descriptions for all functions related to the CONTROLS and SWITCHES on the front panel of the IC-28A/E/H.

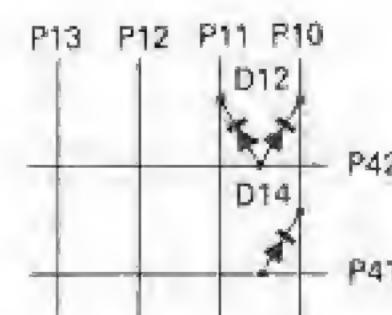
4 - 4 - 2 MATRIX PORT ALLOCATIONS

PORT NUMBER	DESCRIPTION
P41 → P10 ~ P13	This flow sets a band width.
P42 → P10	This flow sets the IF shift direction in receive mode. When the flow is activated, the IF shift selects (-) direction.
P42 ← P11	This flow sets the IF frequency. When the flow is activated, the IF frequency is selected at 17.2MHz.
P42 ← P12	No function.
P43 → P10	This flow activates the [SET] SWITCH function.
P43 → P11	These are squelch signal ports. When the SQLS line becomes "HIGH", Q4 is switched ON.
P43 → P12	These are input ports for the microphone UP/DOWN clock (CK) signals. Q4 is switched ON while either the UP or DOWN SWITCH on the microphone is pushed.
P43 → P13	These are input ports for the microphone UP/DOWN signals. Q5 is switched ON while the UP SWITCH on the microphone is pushed.
P50 → P10	These ports are used in the Japanese IC-28 version.
P50 → P11	These are input ports for the [VFO] SWITCH, and change the mode from memory mode to VFO mode.
P50 → P12	These are input ports for the [MR] SWITCH, and change modes from the VFO mode to memory mode.
P51 → P10, P11	These are input ports for the UP/DOWN signals on the MAIN DIAL.
P51 → P12, P13	These are input ports for the [DOWN/UP] SWITCH.
P52 → P10	These are input ports for the [HI/LO] SWITCH. They control output power when the transceiver is in LOW and switch the front panel "LOW" indicator ON or OFF.
P52 → P11	This flow creates the transmit condition. When the [PTT] SWITCH is pushed and the PTT1 line is "LOW", Q11 is switched OFF and Q9 is switched ON. In addition, the SEND line becomes "HIGH" when this matrix flow is activated.
P52 → P12	No function.
P53 → P13	These are input ports for the [WRITE] SWITCH.
P53 → P10	No function.
P53 → P11	When the optional UT-28 is installed, this matrix flow is activated and the SEL1 line becomes "LOW", switching Q10 ON.
P53 → P12	When the optional UT-29 is installed, this matrix flow is activated and the SEL2 line becomes "LOW", switching Q13 ON.
P53 → P13	These are input ports for the [SQL] SWITCH.

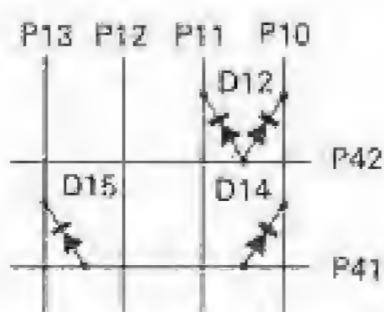
IC-28A/H
(USA VERSIONS)



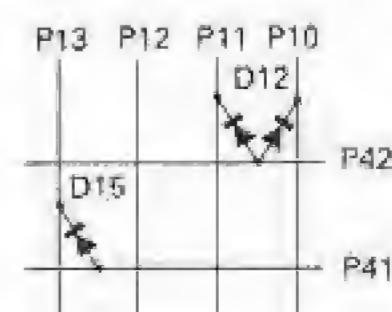
IC-28A/H
(AUSTRALIA VERSIONS)



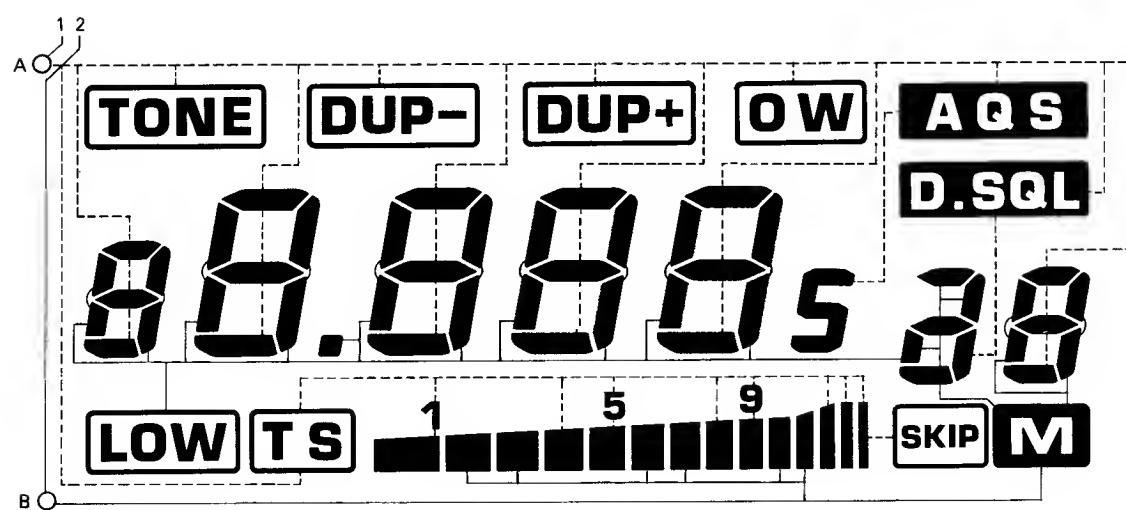
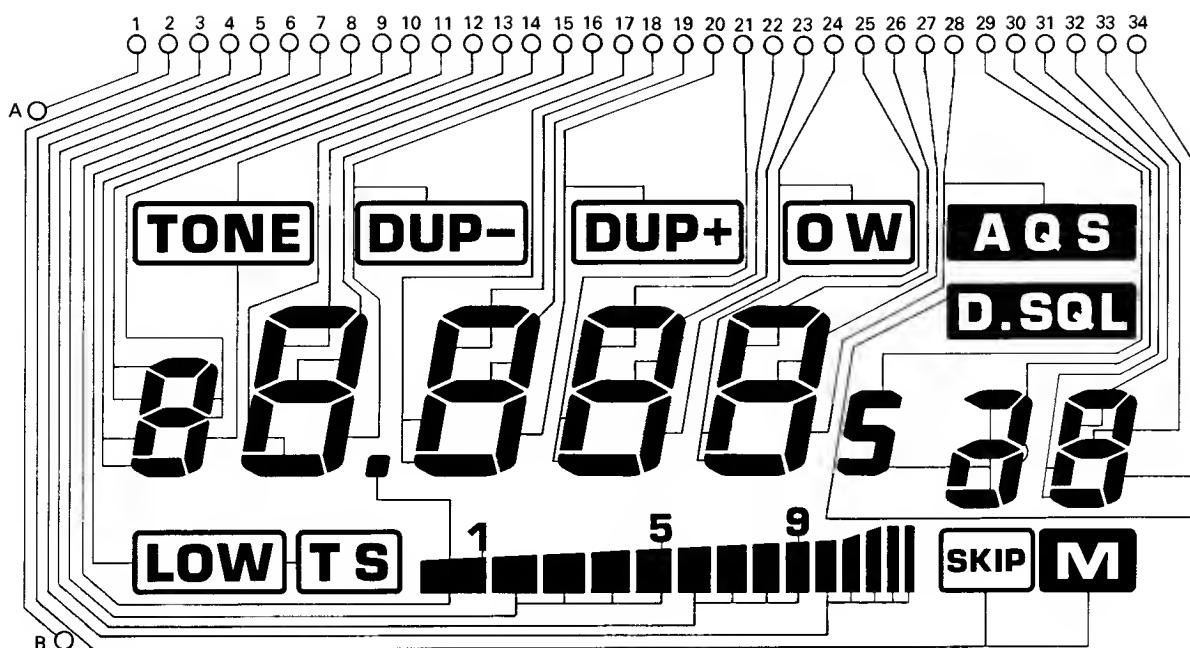
IC-28E/H
(EUROPE VERSIONS)



IC-28E/H
(SPAIN, ITALY VERSIONS)



■ LCD DISPLAY



4 - 4 - 3 S-INDICATOR AND RF-INDICATOR

S/RF signals from ports P71 ~ P73 are fed to R14 ~ R17 which are used for digital/analog (D/A) conversion. The output voltage of the D/A converter is compared with a reference voltage of the S/RF at IC2, a comparator IC chip. If the reference voltage is higher than the voltage of the D/A converter, IC2 outputs "HIGH" level voltage. If the reference voltage is lower, IC2 outputs "LOW" level voltage. The output signal of IC2 is fed to port P60.

• Receiving

When the transceiver is in the receive mode, the S-INDICATOR appears as shown in the chart below.

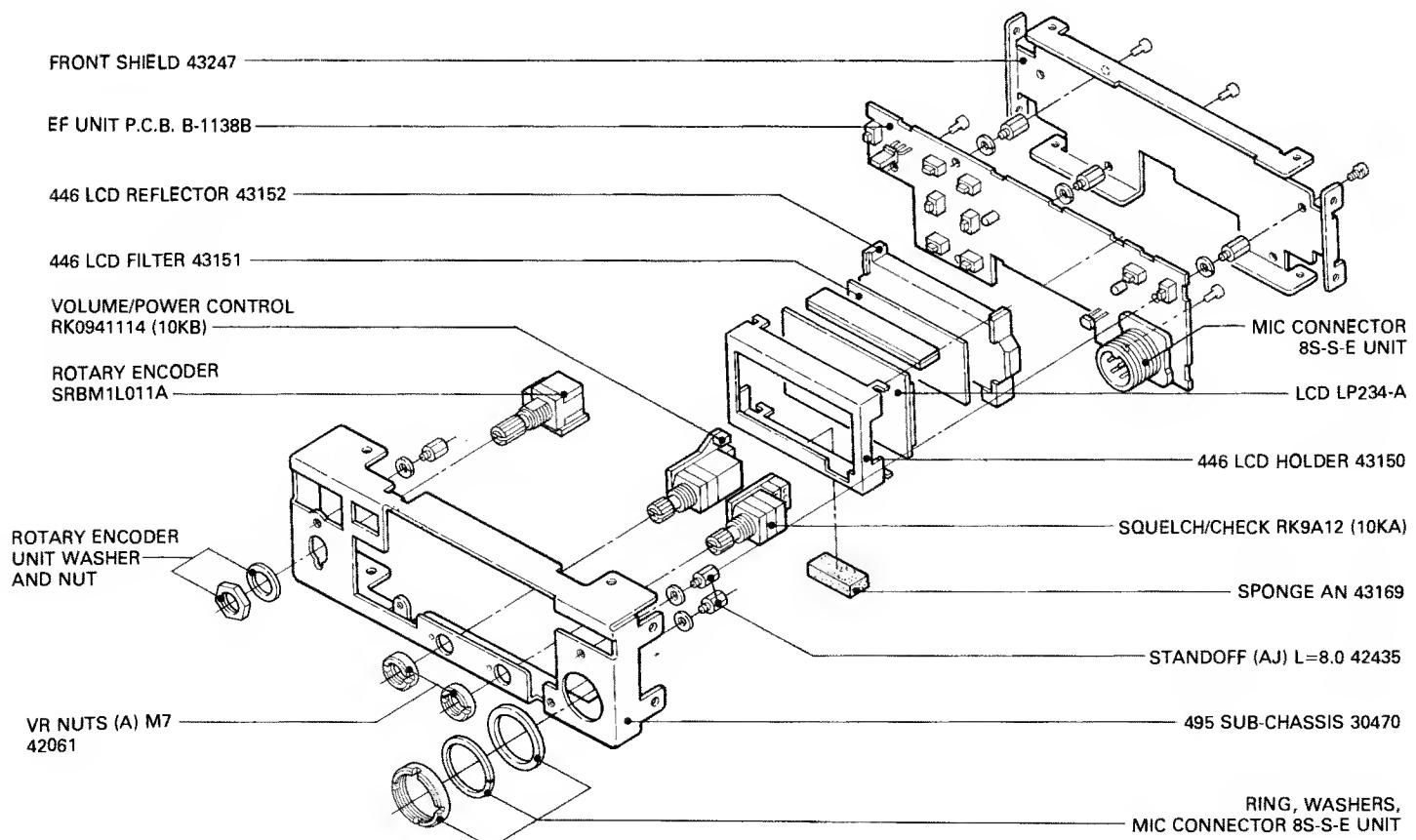
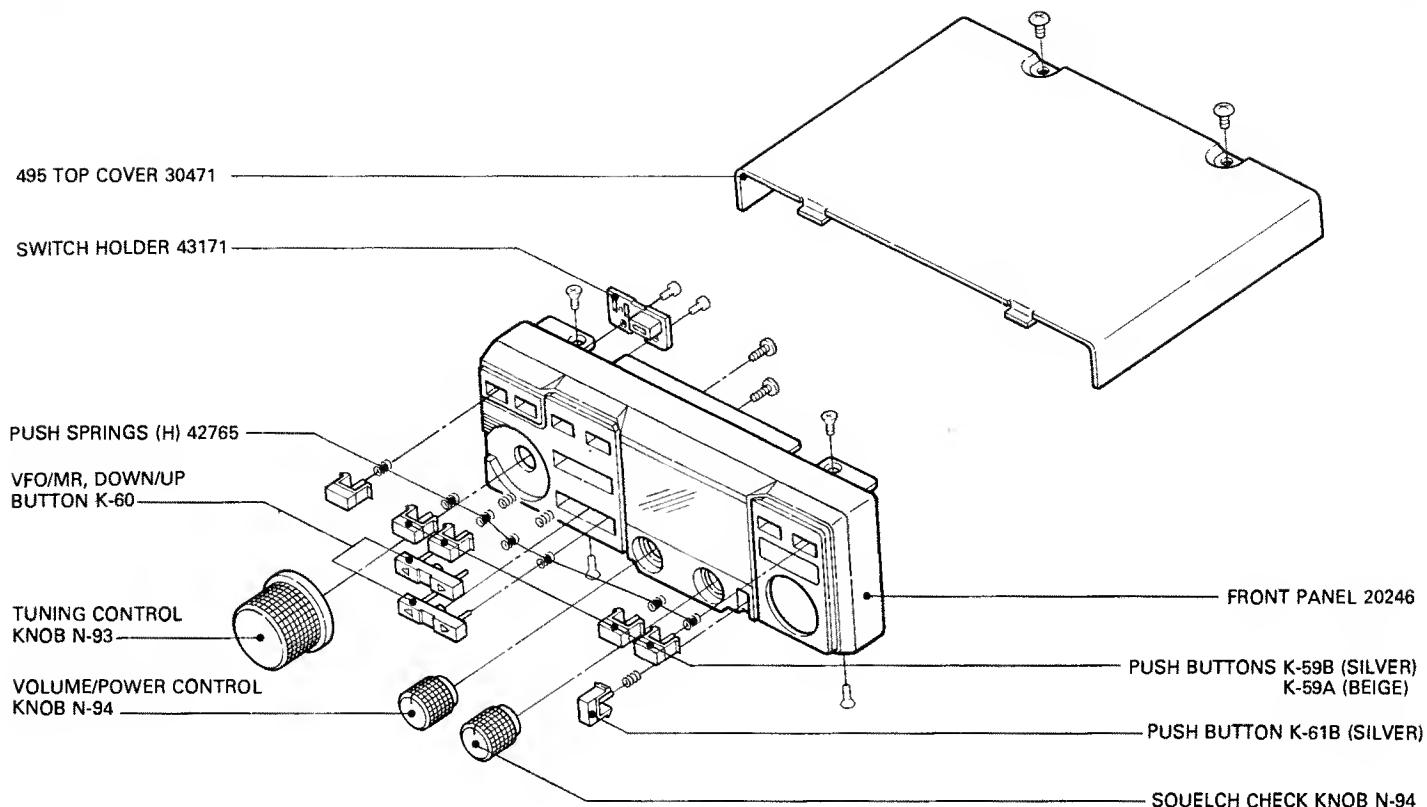
• Transmitting

When transmitting, P71 and P72 output "HIGH", P73 outputs "LOW", and P60 outputs "HIGH". If the high power output is selected, all ports from P71 ~ P73 are "HIGH" and the bar indicator appears at S-7. If low power output is selected, the bar indicator appears at S-3. When P60 is "LOW", the bar indicator does not appear on the LCD DISPLAY.

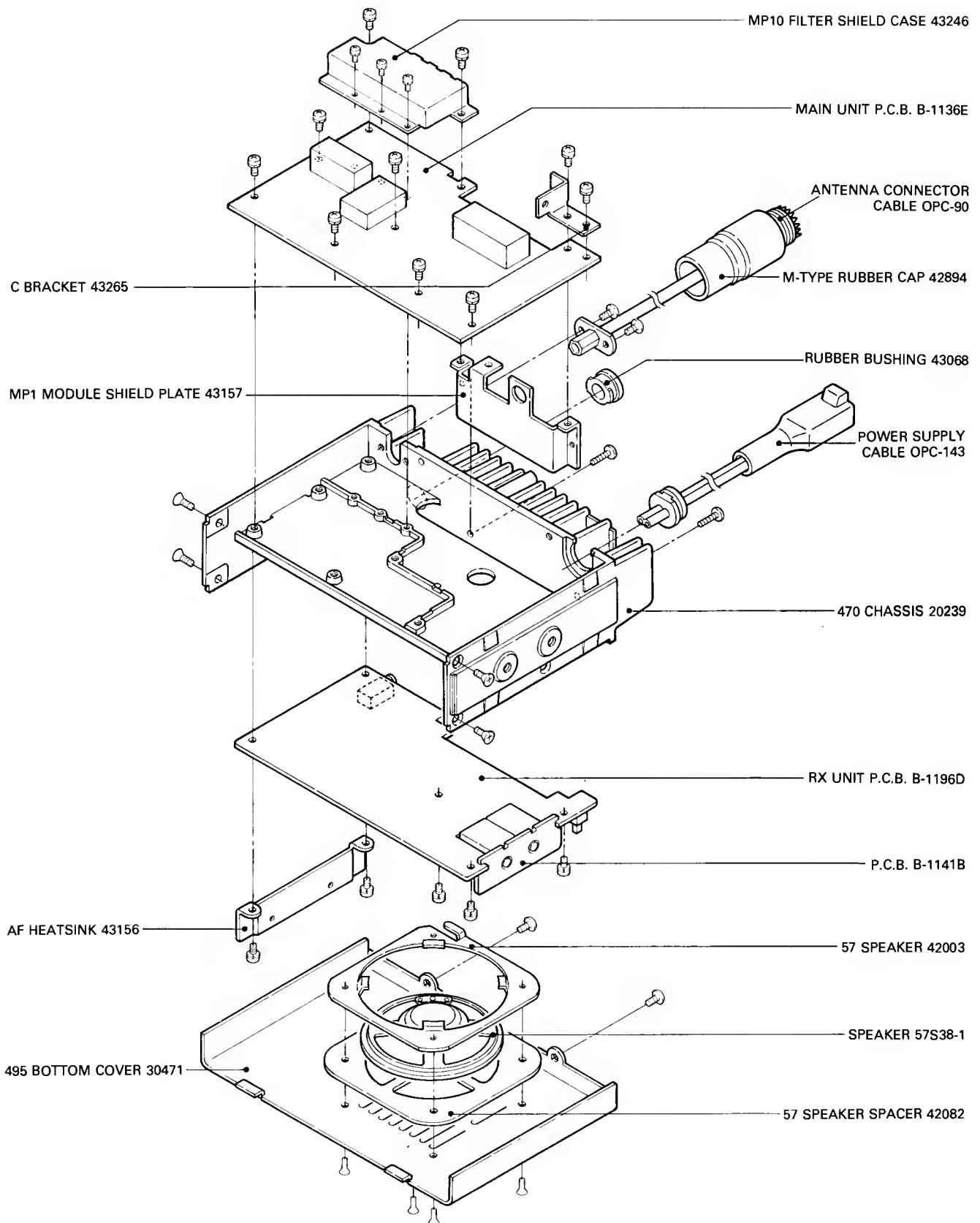
P73	P72	P71	NO. OF BARS
L	L	L	S-0
L	L	H	S-1
L	H	L	S-3
L	H	H	S-5
H	L	L	S-7
H	L	H	S-9
H	H	L	S-11
H	H	H	S-14

SECTION 5 DISASSEMBLY AND ASSEMBLY DIAGRAMS

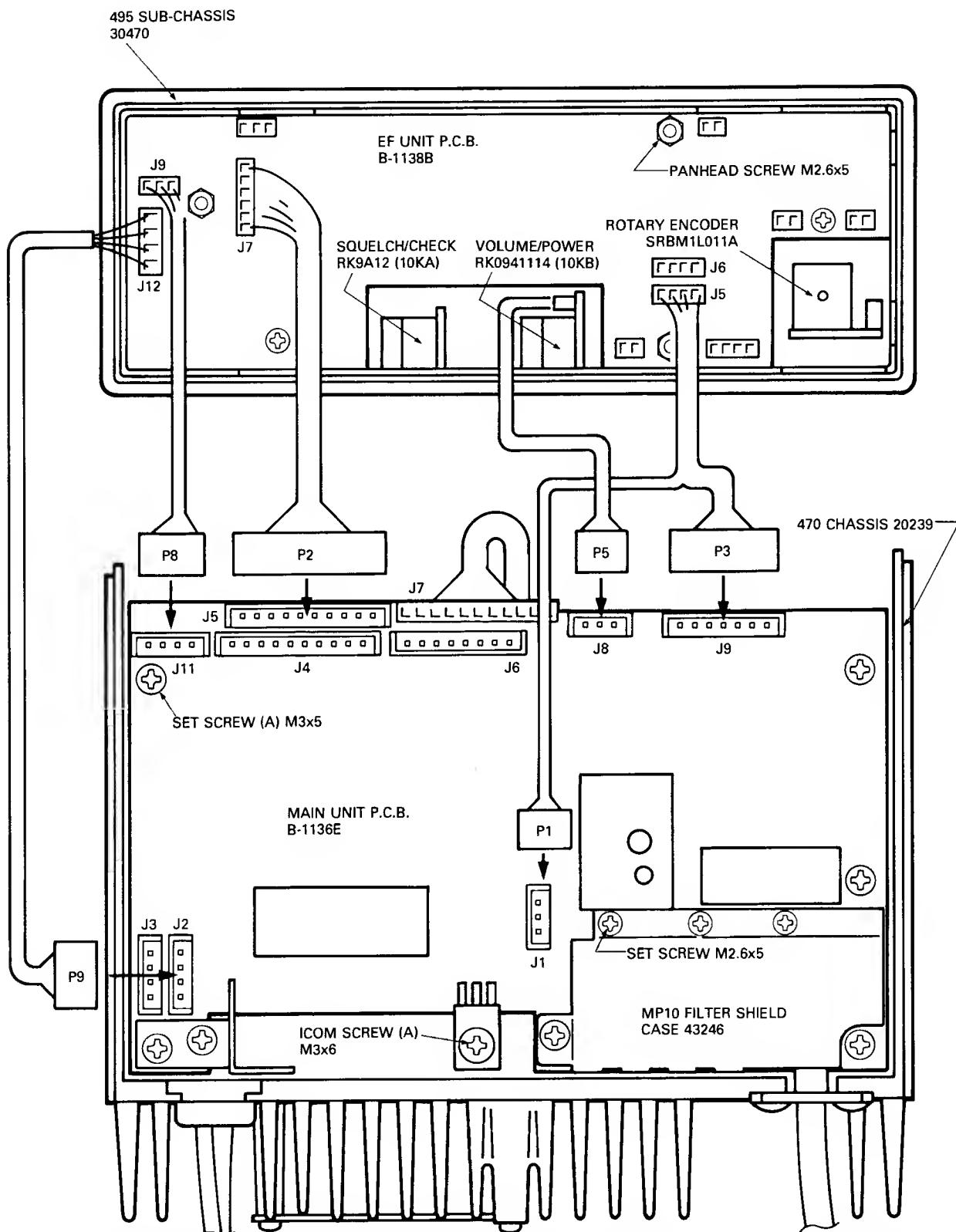
5 - 1 FRONT PANEL DISASSEMBLY



5 - 2 FRAME DISASSEMBLY

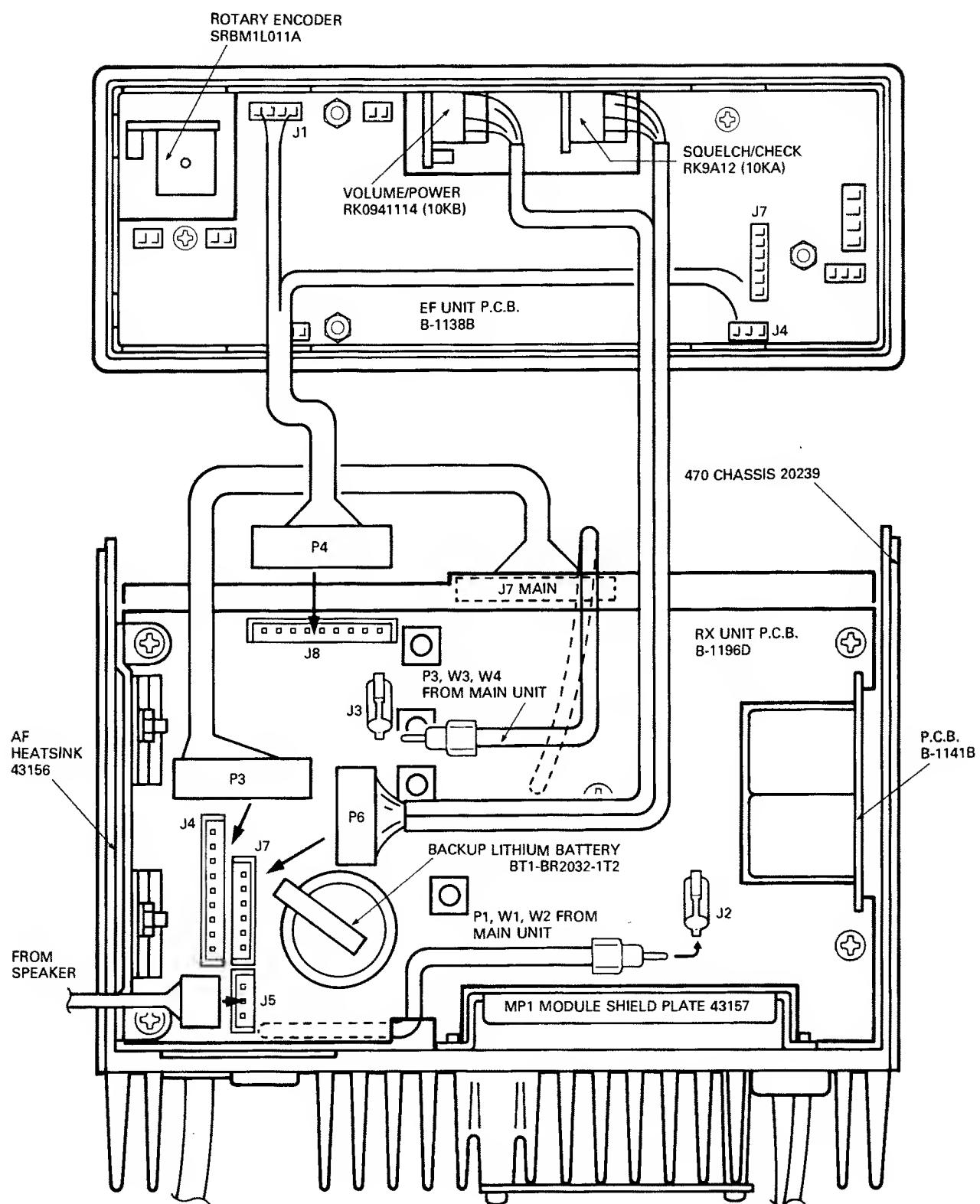


5 - 3 MAIN UNIT CONNECTOR ASSEMBLY (IC-28A/E VERSIONS)

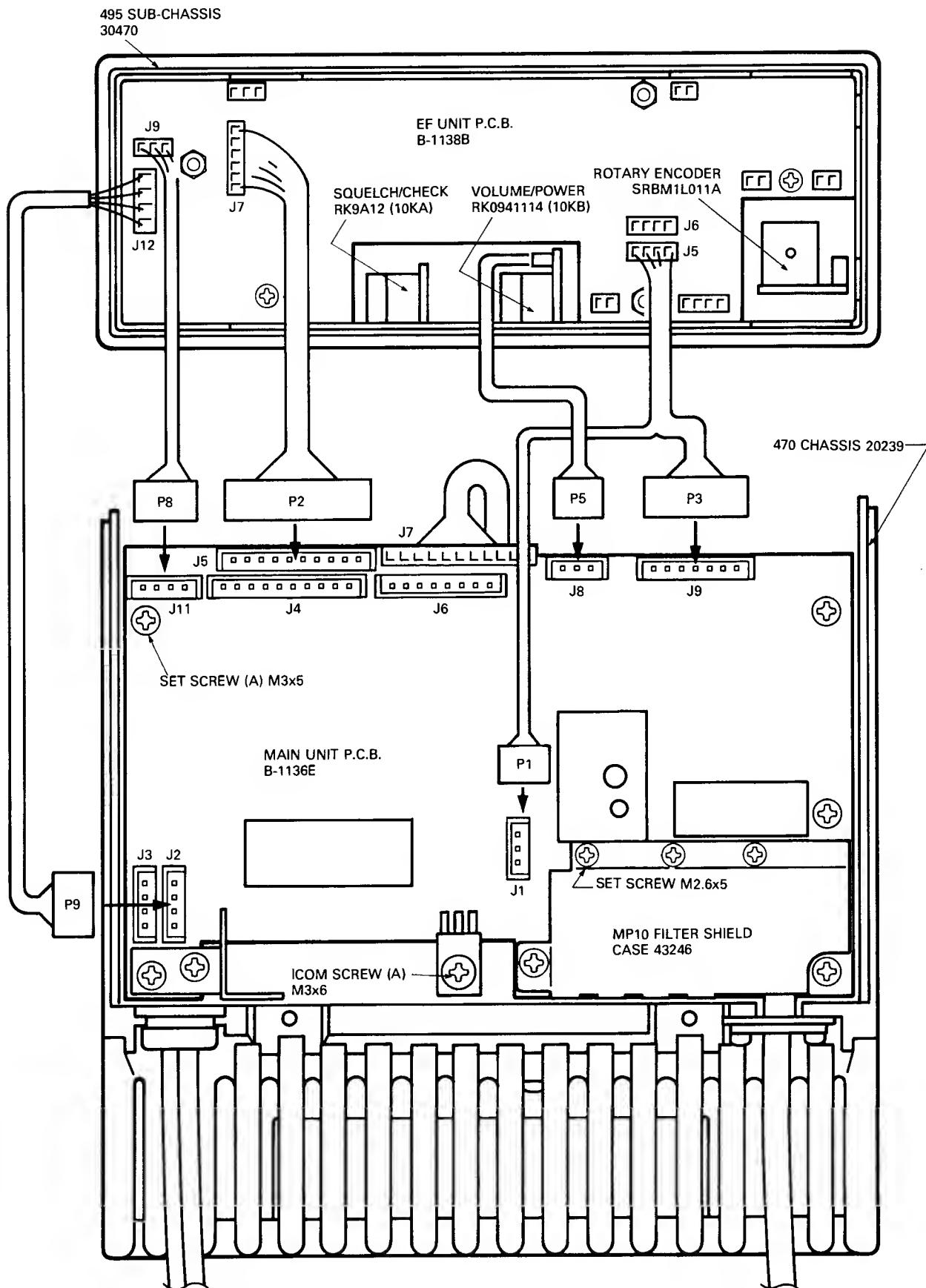


Downloaded by
RadioAmateur.EU

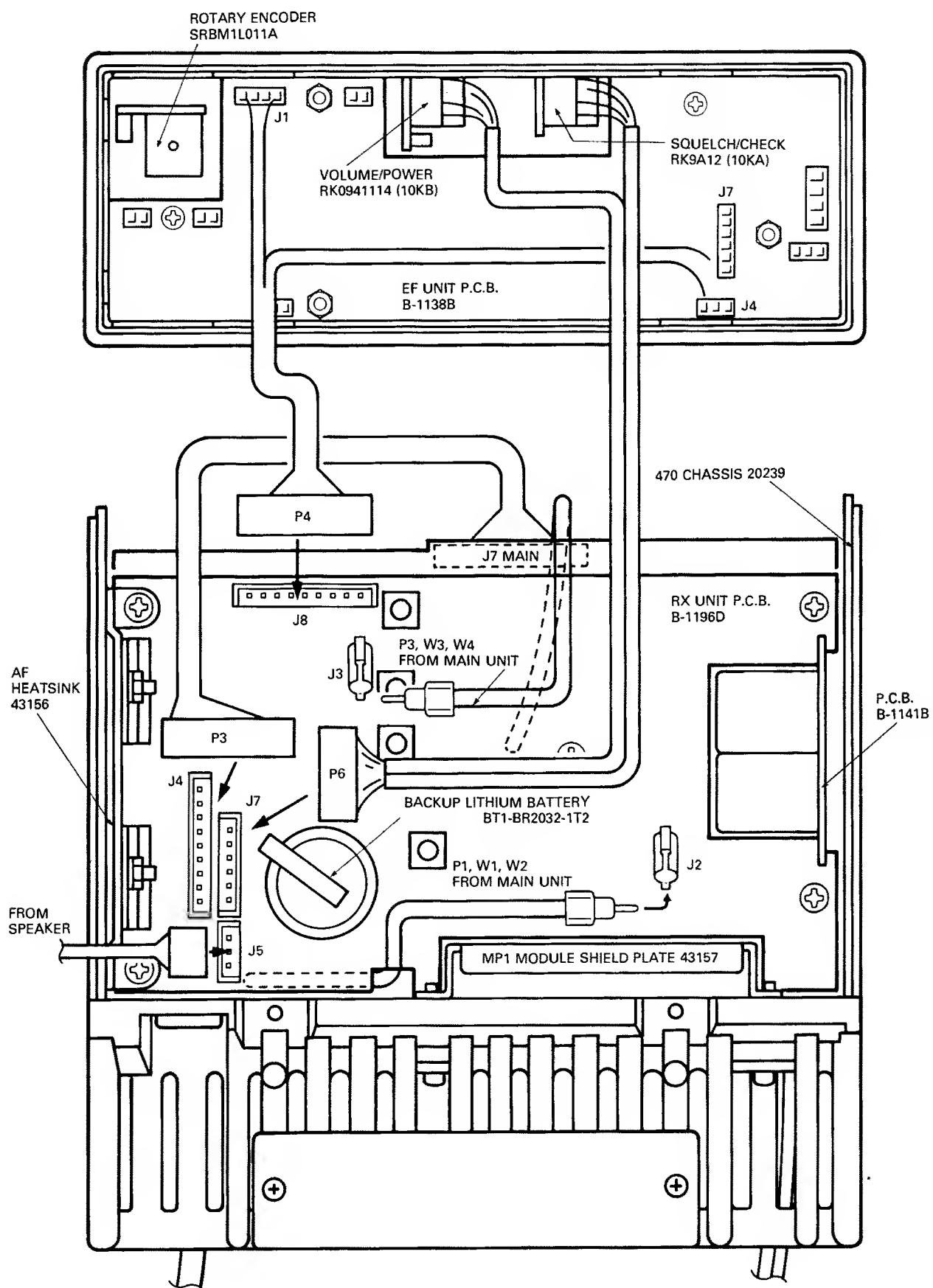
5 - 4 RX UNIT CONNECTOR ASSEMBLY (IC-28A/E VERSIONS)



5 - 5 MAIN UNIT CONNECTOR ASSEMBLY (IC-28H VERSIONS)



5 - 6 RX UNIT CONNECTOR ASSEMBLY (IC-28H VERSIONS)



SECTION 6 MAINTENANCE AND ADJUSTMENT

6 - 1 PREPARATION BEFORE SERVICING

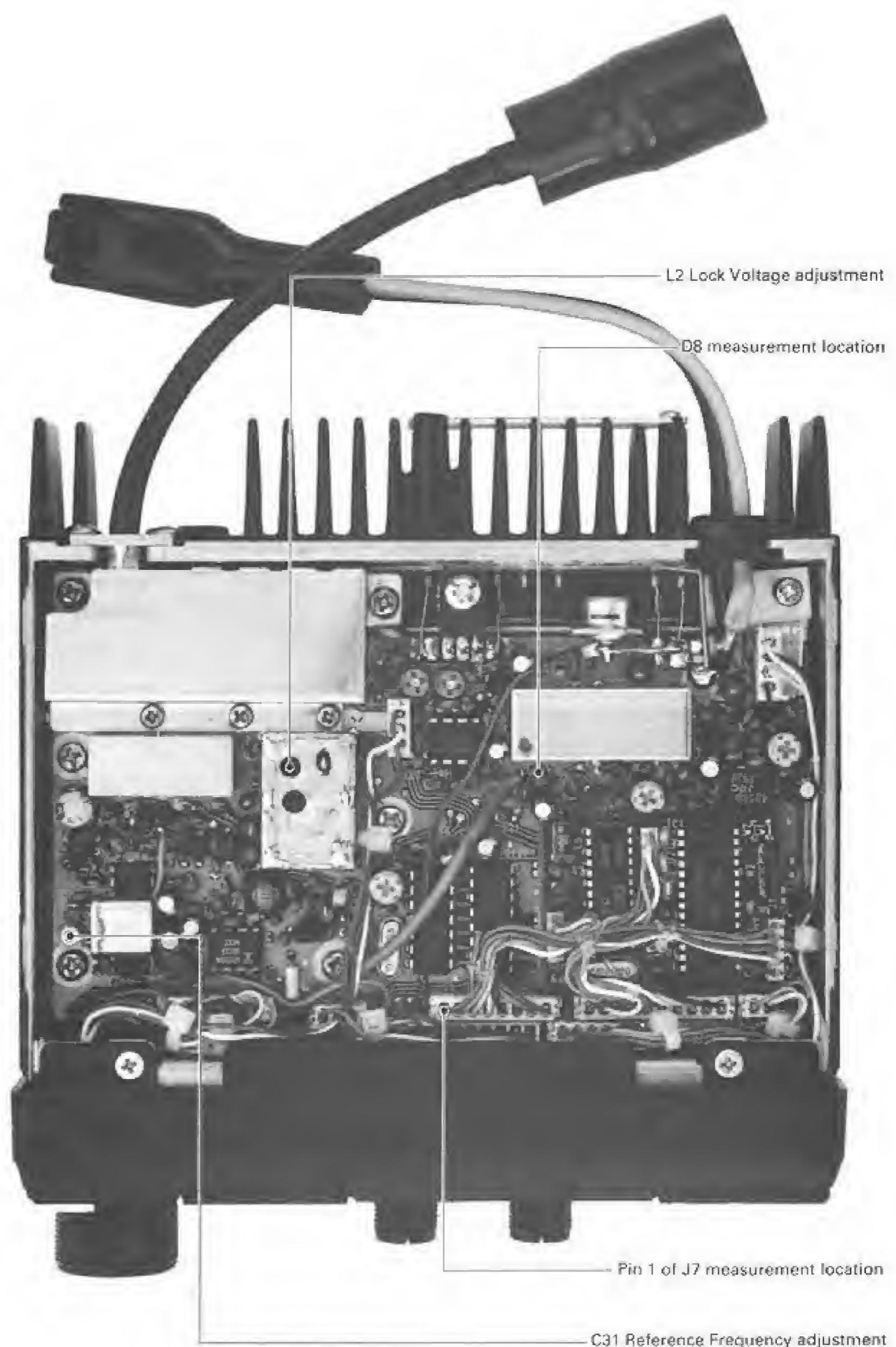
1. Detach the power cord and turn OFF the VOLUME CONTROL/POWER SWITCH before performing any work on the transceiver.
2. Do not short circuit components while making adjustments.
3. Use an insulated tuning tool for all adjustments. Be sure to use the correct tools and test equipment.
4. Follow the instructions exactly. If an indicated result is not obtained, repeat the instruction until the correct result is obtained.
5. Check the condition of connectors, solder joints and screws when adjustments are complete. Confirm that components do not touch each other.
6. Attach a 13.8 volt DC external power source to the power supply connector. Be sure to check the polarity.
7. Recheck for the suspected malfunction with the VOLUME CONTROL/POWER SWITCH ON.
8. Check the defective circuit. Measure the DC voltages of the collector, base and emitter of each transistor.

6 - 2 PLL ADJUSTMENT

NOTE: Adjustment requirements are generally the same for each IC-28A/E/H version. Variations are noted in brackets.

TEST INSTRUMENTS REQUIRED		MEASUREMENT CONNECTION LOCATION		
(1) VOLTAGE REGULATED POWER SUPPLY • Output voltage : 13.8V DC $\pm 15\%$ • Current capacity : 10A or more				
(2) VOLTMETER • Input impedance : 50k Ω /V DC or better				
(3) FREQUENCY COUNTER • Frequency minimum : 0.1 ~ 470MHz • Frequency accuracy : 1ppm or better • Sensitivity : 100mV or better				
ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT	VALUE	ADJUSTMENT POINT
LOCK VOLTAGE	1 • Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Receive mode	MAIN UNIT LOCATION	MAIN 6.0V (#01) 5.5V (#03, #04, #05)	MAIN L2
REFERENCE FREQUENCY	1 • Display frequency 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Receive mode	MAIN UNIT LOCATION	MAIN 128.810MHz (#01) 127.800MHz (#03, #04, #05)	MAIN C31

MAIN UNIT

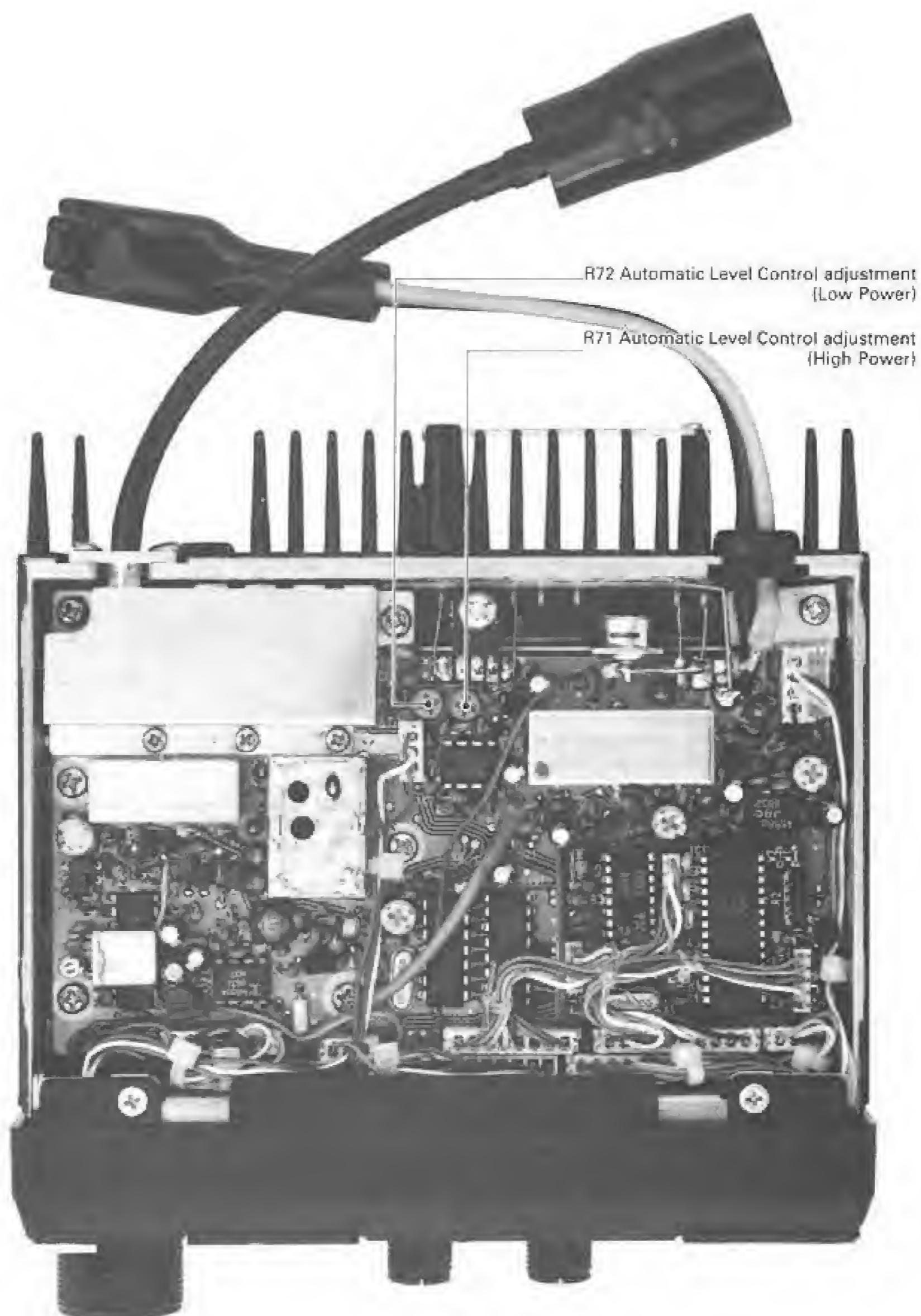


6 - 3 TRANSMITTER ADJUSTMENT

TEST INSTRUMENTS REQUIRED		MEASUREMENT CONNECTION/LOCATION	
<p>(1) VOLTAGE REGULATED POWER SUPPLY</p> <ul style="list-style-type: none"> • Output voltage : 13.8V DC $\pm 15\%$ • Current capacity : 10A or more <p>(2) RF POWER METER</p> <ul style="list-style-type: none"> • Terminated type • Minimum power rating : 150W • Frequency minimum : 30MHz • Input impedance : 50Ω • SWR : 1:1.2 or better <p>(3) AMMETER</p> <ul style="list-style-type: none"> • Input impedance : 50kΩ/V DC or better • Measurement minimum : 100mA and 600mA <p>(4) DEVIATION METER</p> <ul style="list-style-type: none"> • Frequency minimum : 30MHz • Measuring range : 0 ~ $\pm 5\text{kHz}$ • De-emphasis : OFF <p>(5) AC MILLI-VOLTMETER</p> <ul style="list-style-type: none"> • Measuring range : 5mV ~ 1V <p>(6) ATTENUATOR</p>		<p>Also connects to ANTENNA CONNECTOR</p>	

ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
		UNIT	LOCATION		UNIT	ADJUST
ALC (Automatic Level Control) ⑥ HIGH POWER	1	REAR PANEL	Connect an RF power meter to the ANTENNA CONNECTOR.	27W 47W (IC-28H version)	MAIN	R71
	2			5W		
VERIFY OUTPUT POWER AT BAND EDGES	1	REAR PANEL	Connect an RF power meter to the ANTENNA CONNECTOR.	More than 25W More than 45W (IC-28H version)	Verify	
	2			4 ~ 6W		

MAIN UNIT



TRANSMITTER ADJUSTMENT

ADJUSTMENT		ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
			UNIT	LOCATION		UNIT	ADJUST
RF LEVEL INDICATOR	1	<ul style="list-style-type: none"> • Frequency display: 146.010 (#01) 145.000 (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode 	DISPLAY		Full scale		Verify
	2	<ul style="list-style-type: none"> • HIGH/LOW POWER: LOW 					Verify
TRANSMIT CURRENT	1	<ul style="list-style-type: none"> • Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode 	REAR PANEL	<p>Connect an Ammeter between the Power supply and the transceiver.</p>	<p>Less than 5.8A Less than 9.5A (IC-28H version)</p>		Verify
	2	<ul style="list-style-type: none"> • HIGH/LOW POWER: LOW 					Verify
DEVIATION @ MAXIMUM	1	<ul style="list-style-type: none"> • Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode 	REAR PANEL	<p>Connect a Deviation meter to the ANTENNA CONNECTOR through an attenuator.</p>	±4.8kHz	MAIN	R100
	2	<ul style="list-style-type: none"> • Apply a 1kHz 65mV AF signal to the MIC CONNECTOR (#01) • Apply a 1kHz 20mV AF signal to the MIC CONNECTOR (#03, #04, #05) 					
@ 70%	2	<ul style="list-style-type: none"> • Apply 1kHz 6.5mV (20dB down) to the MIC CONNECTOR (#01) • Apply 1kHz 2.0mV (20dB down) to the MIC CONNECTOR (#03, #04, #05) 					
	1	<ul style="list-style-type: none"> • Frequency display: 146.010MHz • Tone number: 38 • Apply no signal to the MIC CONNECTOR • Transmit mode 	REAR PANEL	<p>Connect a Deviation meter to the ANTENNA CONNECTOR through an attenuator.</p>	<p>±0.75kHz ±0.5 ~ ±1kHz</p>	MAIN	R48
	2	<ul style="list-style-type: none"> • Tone number: 01 					Verify
S/N RATIO	1	<ul style="list-style-type: none"> • Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Apply a 1kHz 6.5mV AF signal to the MIC CONNECTOR (#01) • Apply a 1kHz 2.0mV AF signal to the MIC CONNECTOR (#03, #04, #05) • Transmit mode 	REAR PANEL	<p>Connect an AC Milli-voltmeter to the Deviation meter.</p>	Record the reading.		
	2	<ul style="list-style-type: none"> • Apply no signal to the MIC CONNECTOR 					Record the reading.
<p>NOTE: Verify that the recorded ratio is greater than 40dB (See steps 1 and 2).</p>							

MAIN UNIT

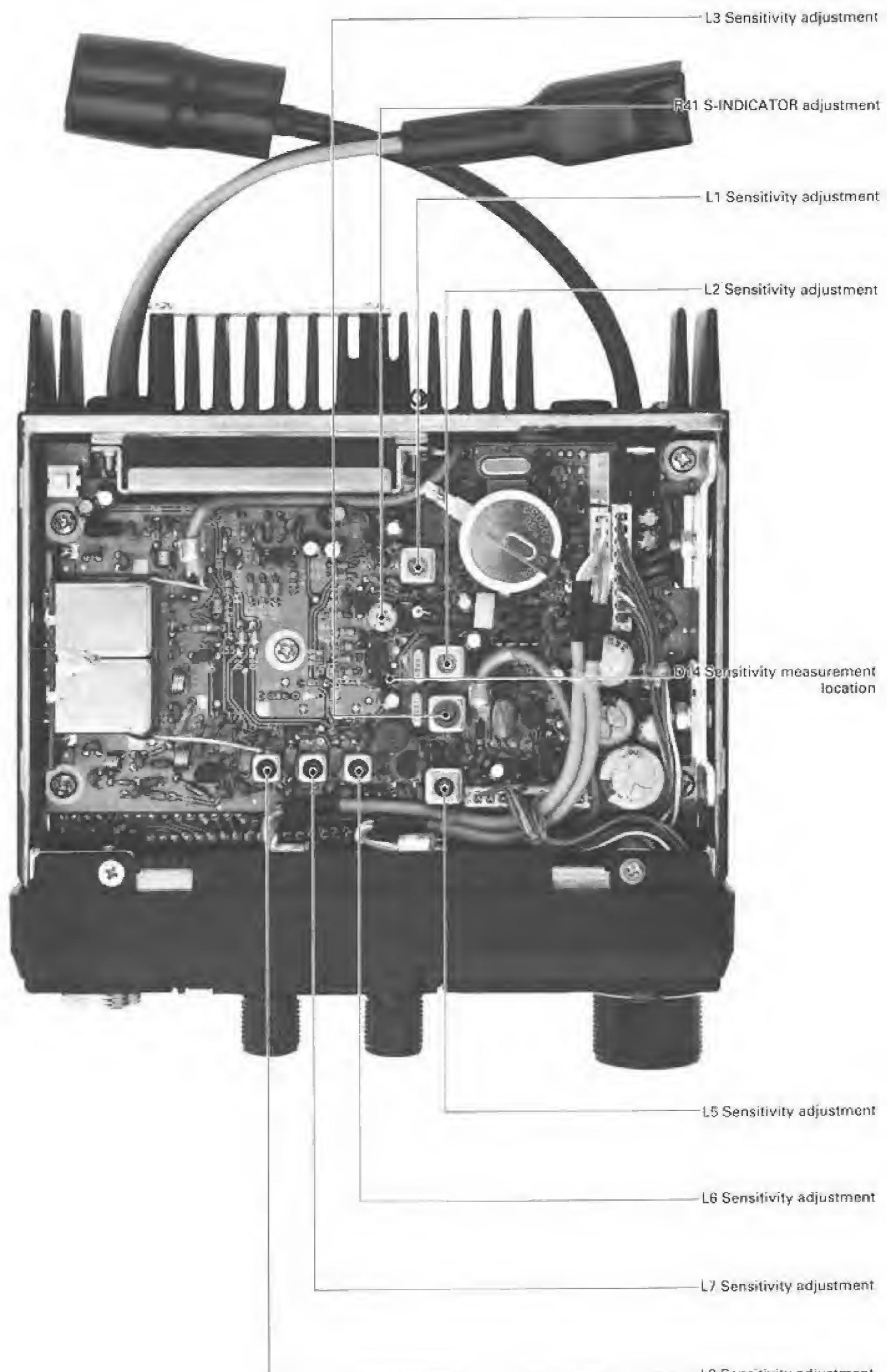


6 - 4 RECEIVER ADJUSTMENT

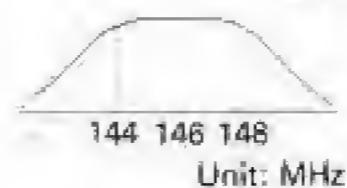
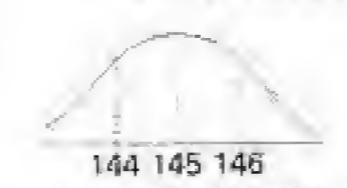
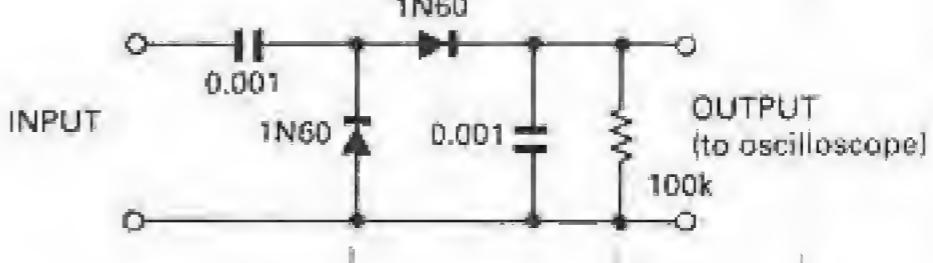
TEST INSTRUMENTS REQUIRED		MEASUREMENT CONNECTION LOCATION	
<p>(1) VOLTAGE REGULATED POWER SUPPLY</p> <ul style="list-style-type: none"> • Output voltage : 13.8V DC $\pm 15\%$ • Current capacity : 10A or more <p>(2) VOLTMETER</p> <ul style="list-style-type: none"> • Input impedance : 50kΩ/V DC or better <p>(3) AC MILLI-VOLTMETER</p> <ul style="list-style-type: none"> • Measuring range : 5mV ~ 1V <p>(4) OSCILLOSCOPE</p> <ul style="list-style-type: none"> • Frequency range : DC ~ 20MHz • Measuring range : 0.01 ~ 10V <p>(5) RF SWEEP GENERATOR</p> <ul style="list-style-type: none"> • Center frequency : 140MHz ~ 150MHz • Sweep bandwidth : $\pm 10\text{MHz}$ • Output impedance : 50Ω <p>(6) DETECTOR</p>			

ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
		UNIT	LOCATION		UNIT	ADJUST
SENSITIVITY	<ul style="list-style-type: none"> • Frequency display: 146.010MHz (#01), 145.000MHz (#03, #04, #05) • Turn R41 completely CW • Apply RF signal to the ANTENNA CONNECTOR Level : 1μV (-107dBm) Deviation : $\pm 3.5\text{kHz}$ Modulation : 1kHz 	RX	Connect a voltmeter to the cathode of D14.	Maximum value	RX	L7, L6 L5, L3 L2, L1
NOTE: Verify that the sensitivity in all bands is below 0.18 μ V (-122dBm) for 12dB SINAD.						
S-INDICATOR	<ul style="list-style-type: none"> • Frequency display: 146.010MHz (#01), 145.000MHz (#03, #04, #05) • Apply RF signal to the ANTENNA CONNECTOR Level : 1μV (-107dBm) Deviation : $\pm 3.5\text{kHz}$ Modulation : 1kHz 	DISPLAY	 S-INDICATOR is at S3.	S3	RX	R41
	<ul style="list-style-type: none"> • Apply RF signal to the ANTENNA CONNECTOR Level : 5.0μV (-93dBm) Deviation : $\pm 3.5\text{kHz}$ Modulation : 1kHz 		 S-INDICATOR is at full scale.	Full scale		Verify

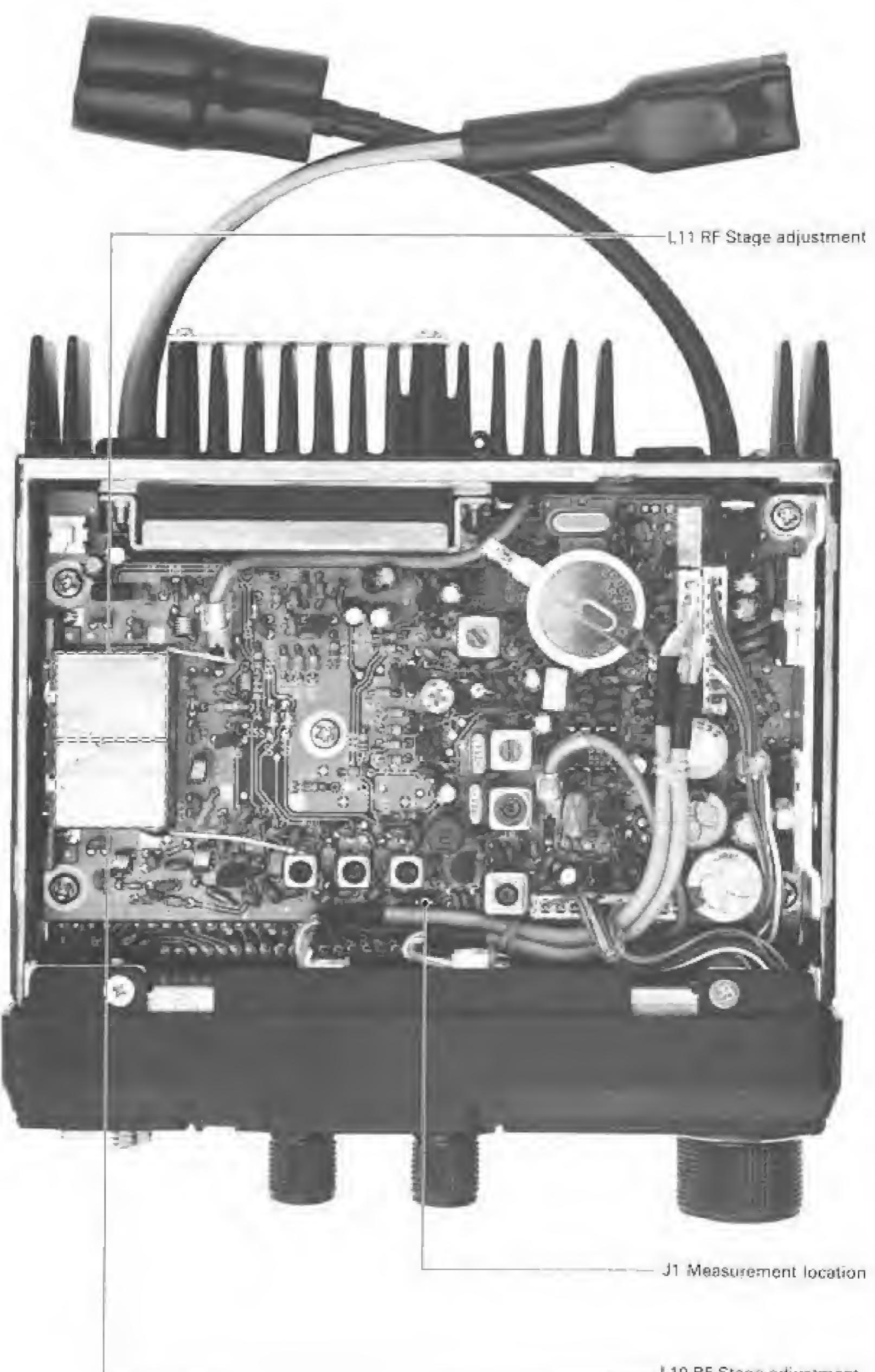
RX UNIT



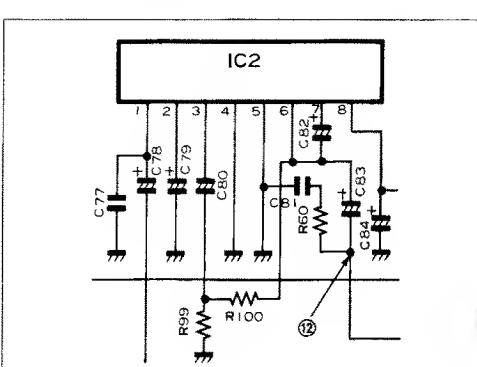
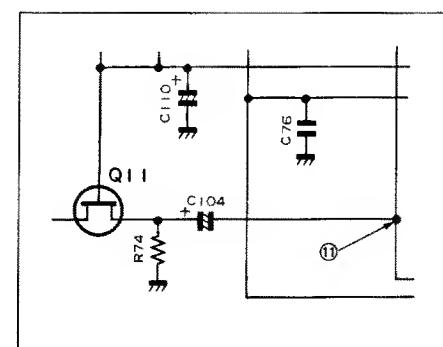
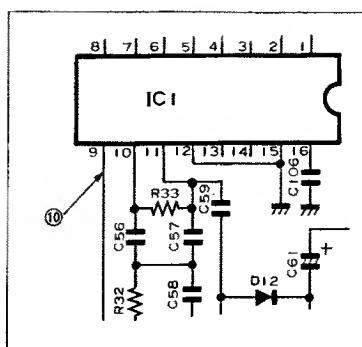
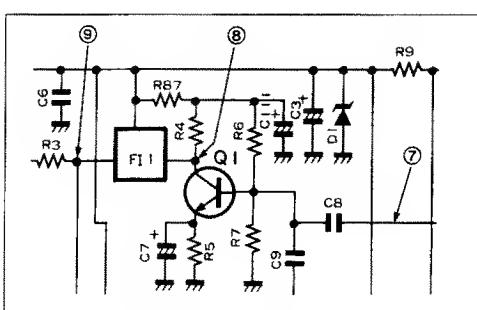
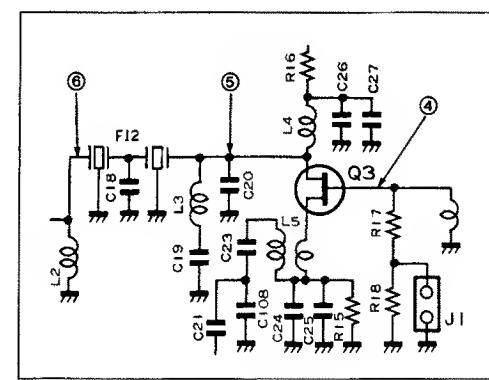
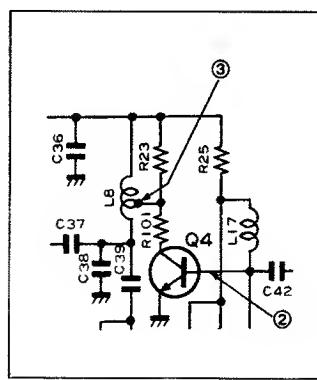
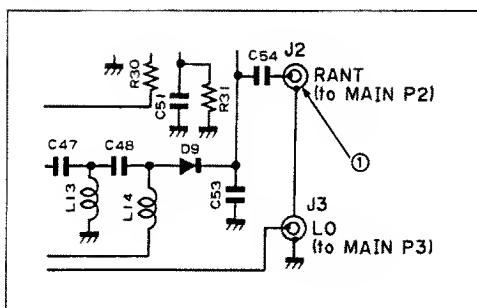
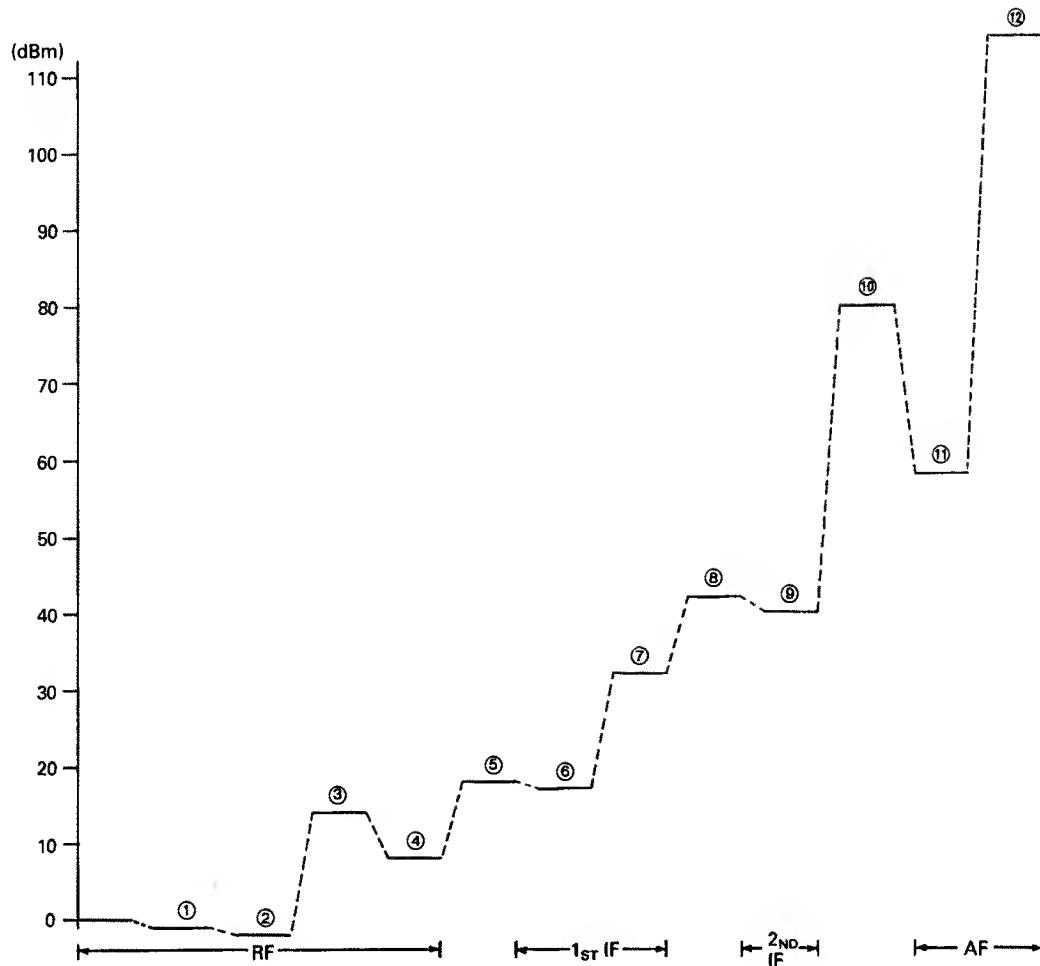
RECEIVER ADJUSTMENT

ADJUSTMENT		ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
			UNIT	LOCATION		UNIT	ADJUST
SQUELCH	1	<ul style="list-style-type: none"> • Apply RF signal to ANTENNA CONNECTOR Level : 0.11µV (-126dBm) Deviation : ±3.5kHz Modulation : 1kHz • Adjust SQUELCH CONTROL to threshold point 			SQUELCH opens		Verify
	2	<ul style="list-style-type: none"> • Apply RF signal to the ANTENNA CONNECTOR Level : 0.5µV (-113dBm) Deviation : ±3.5kHz Modulation : 1kHz • Turn SQUELCH CONTROL to maximum CW 			SQUELCH opens		Verify
AF OUTPUT POWER	1	<ul style="list-style-type: none"> • Apply RF signal to the ANTENNA CONNECTOR Level : 10µV (-87dBm) Deviation : ±3.5kHz Modulation : 1kHz • Turn AF VOLUME CONTROL to maximum CW 	REAR PANEL	Connect an AC milli-voltmeter to the transceiver EXTERNAL SPEAKER JACK using an 8Ω load.	More than 4.4V at 10% distortion.		Verify
RF STAGE	NOTE: The Bandpass Filter unit in the RF stage has been thoroughly adjusted prior to leaving the factory. The following should be regarded as reference material.						
	1	<ul style="list-style-type: none"> • Unplug P2 from J3 • Apply an RF sweep generator to the ANTENNA CONNECTOR • Frequency range: 140MHz ~ 150MHz 	RX	<p>Connect an oscilloscope to J1 through the detector.</p> <p>(#01)</p>  <p>(#03, #04, #05)</p>  <p>Detector Circuit characteristics:</p> 		BPF	L10, L11

RX UNIT



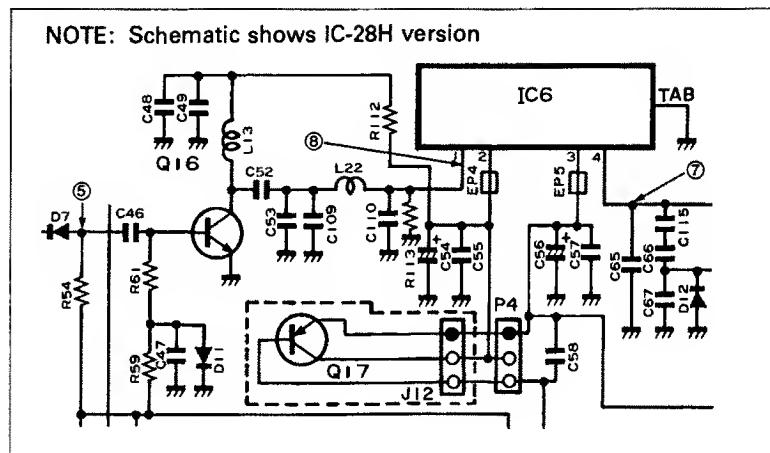
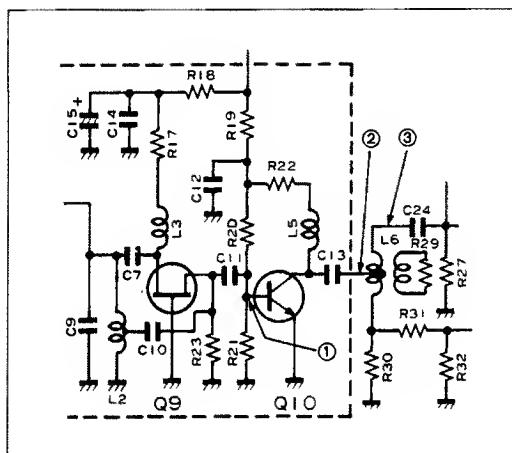
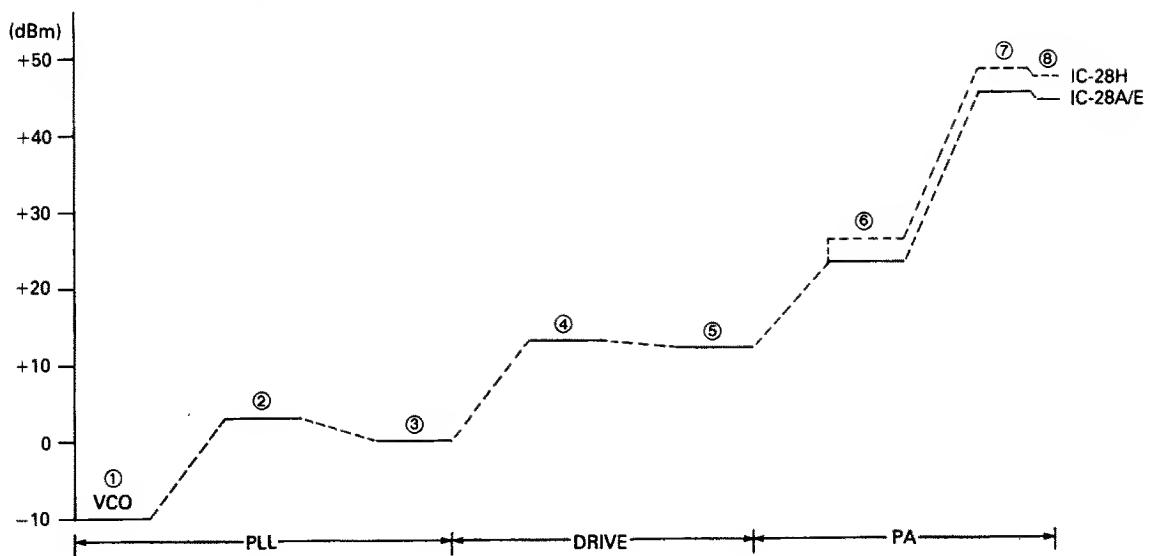
6 - 5 RX LEVEL DIAGRAM



NOTE 1: For an accurate measure of the above levels, ensure that the impedance of your test equipment matches the impedance of the various test points.

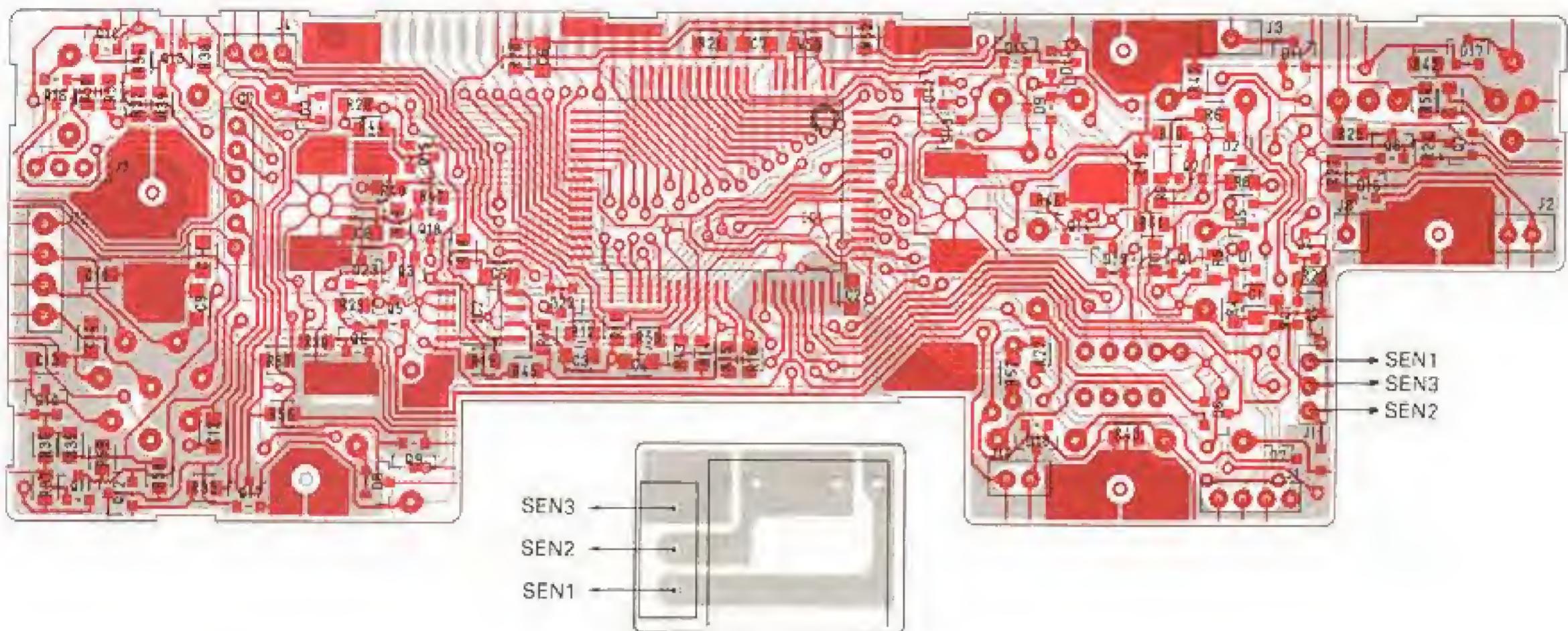
NOTE 2: The above levels are approximate to within ± 6 dB.

6 - 6 TX LEVEL DIAGRAM

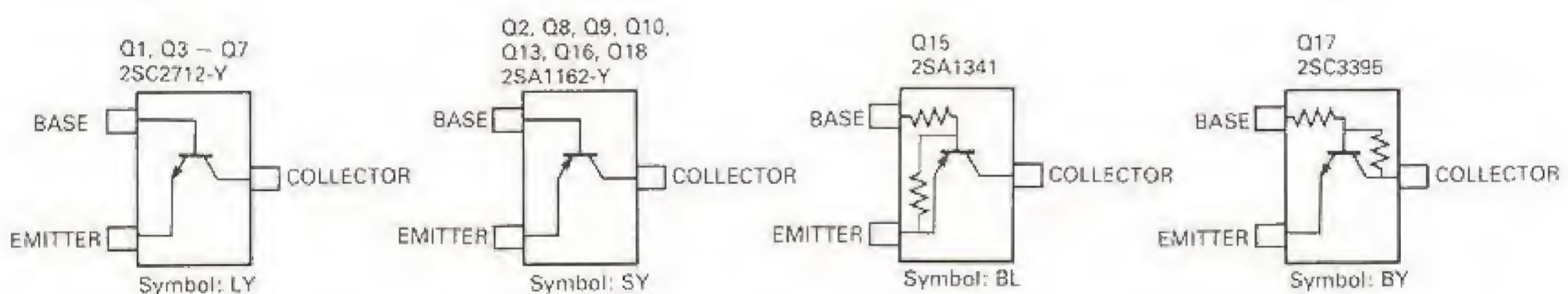


SECTION 7 BOARD LAYOUTS

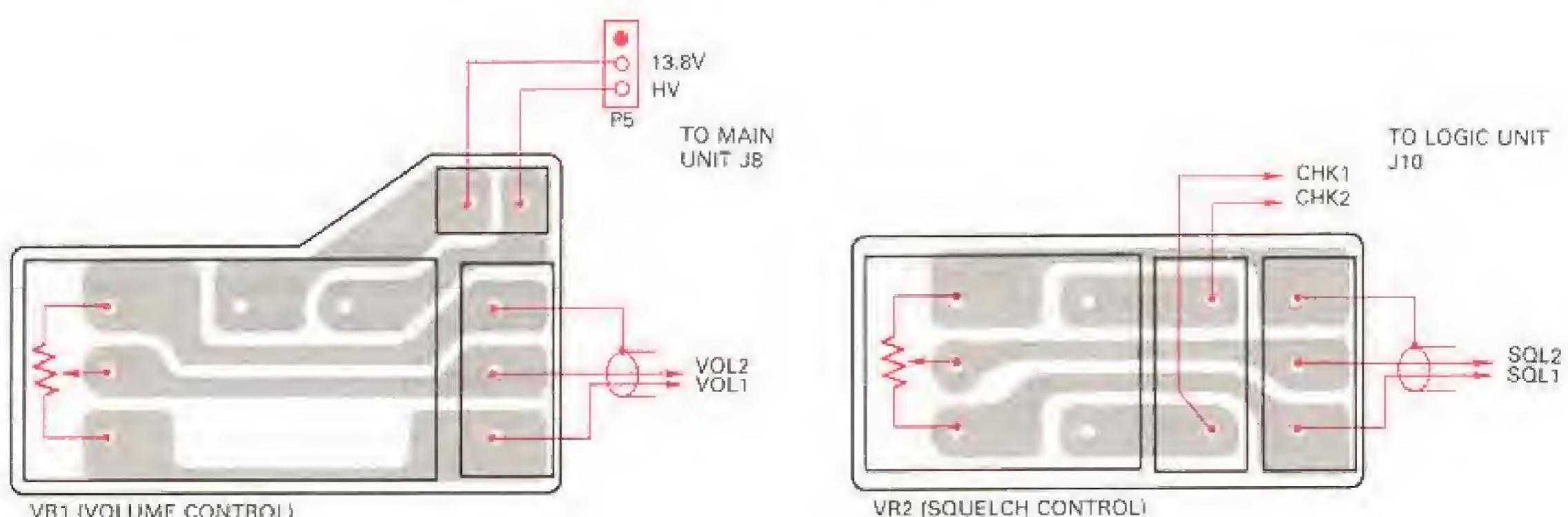
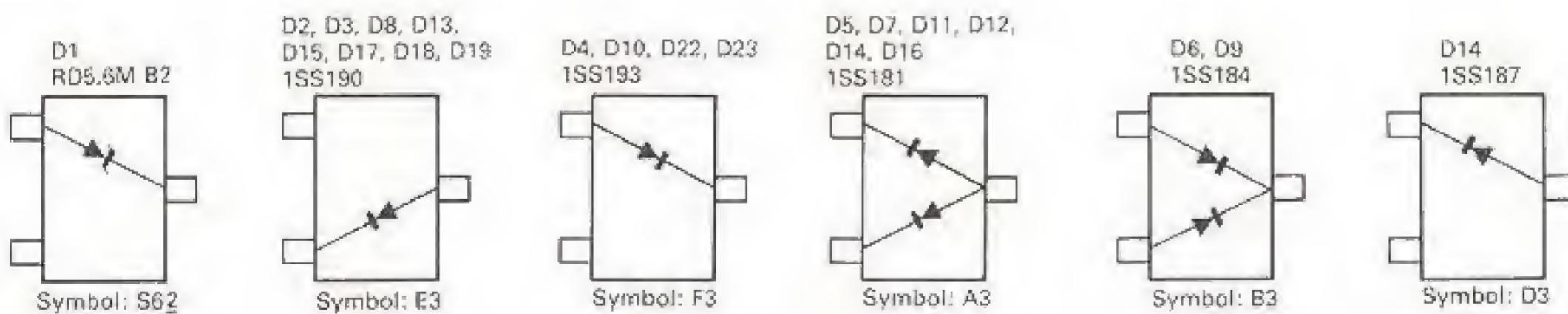
7 - 1 EF UNIT



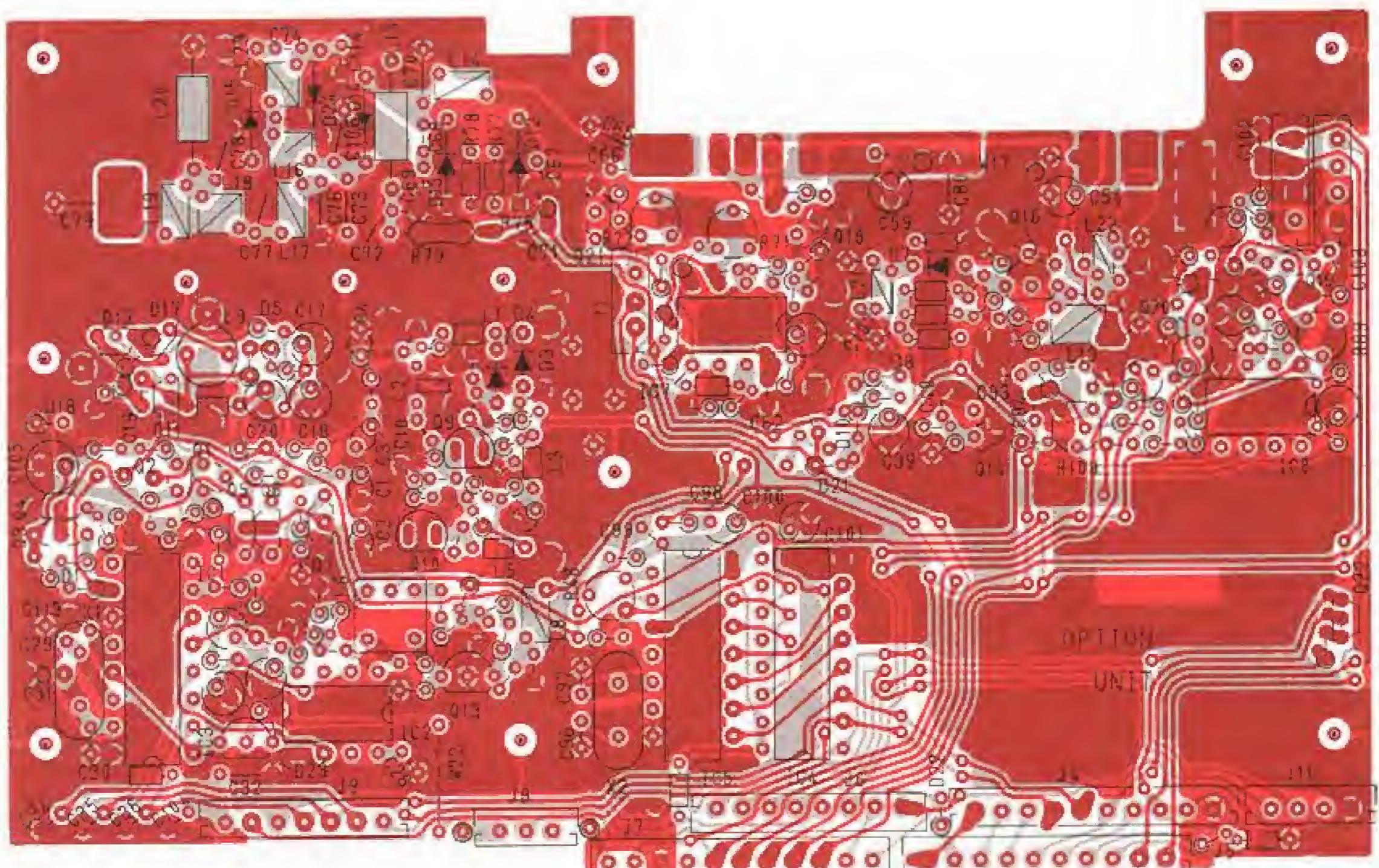
■ TRANSISTORS



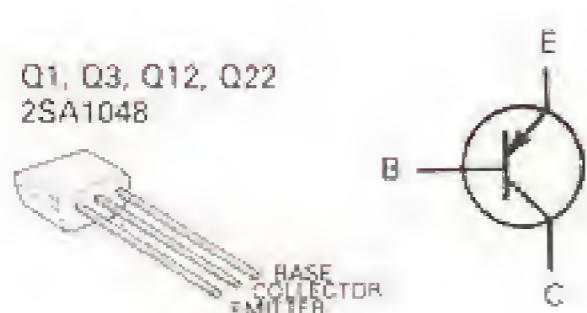
■ DIODES



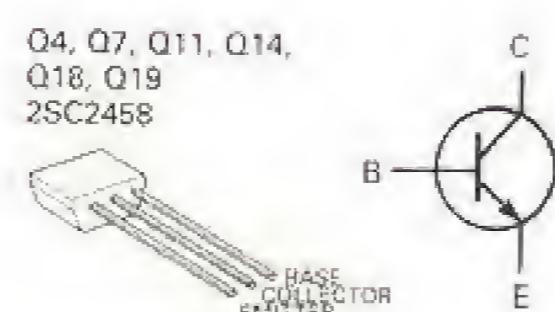
7 - 2 MAIN UNIT (IC-28A/E VERSIONS)



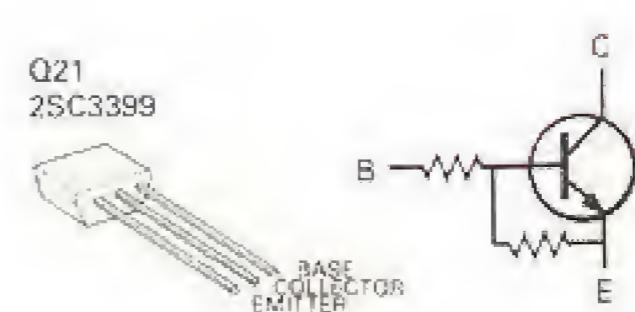
Q1, Q3, Q12, Q22
2SA1048



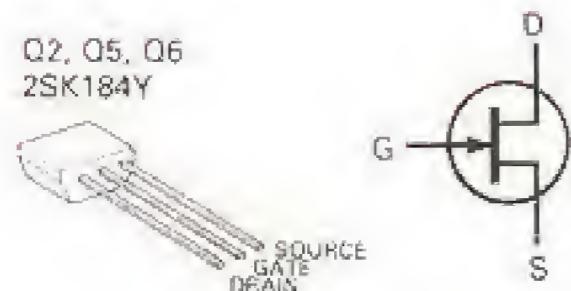
Q4, Q7, Q11, Q14,
Q18, Q19
2SC2458



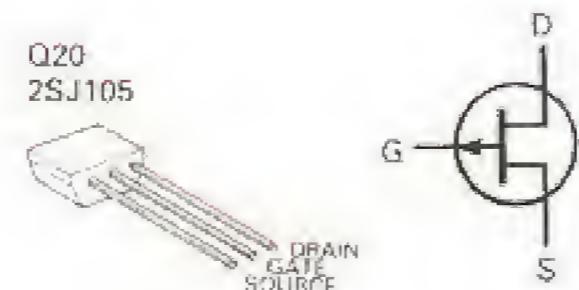
Q21
2SC3399



Q2, Q5, Q6
2SK184Y



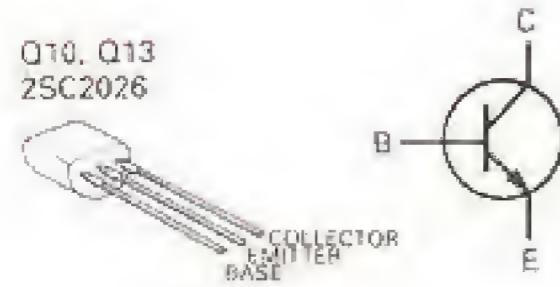
Q20
2SJ105



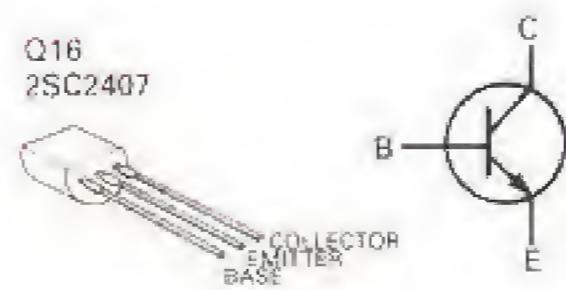
Q9
2SK125



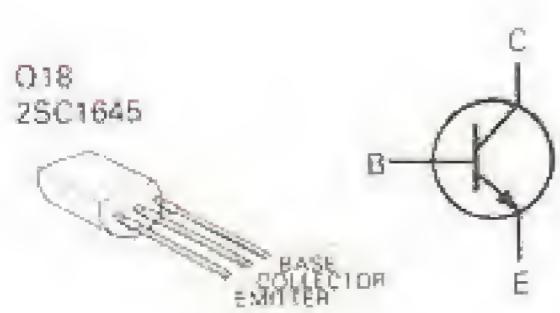
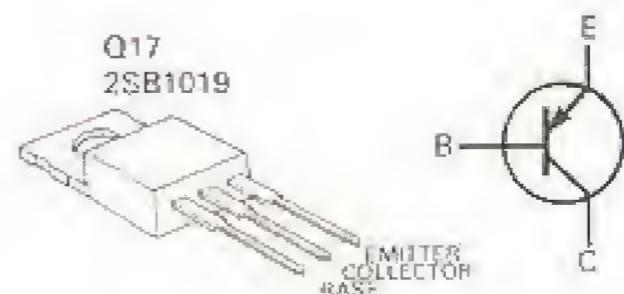
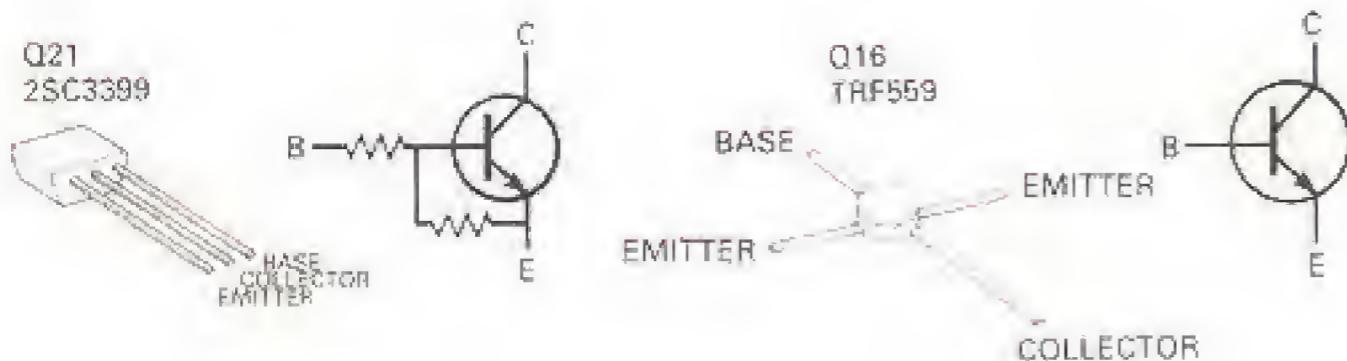
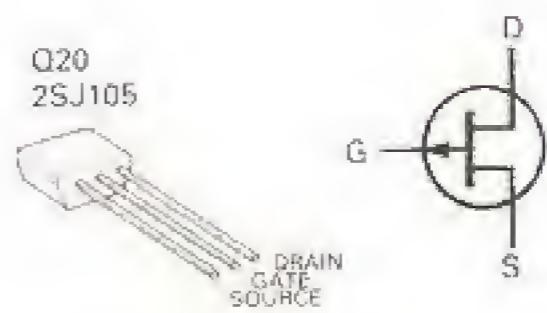
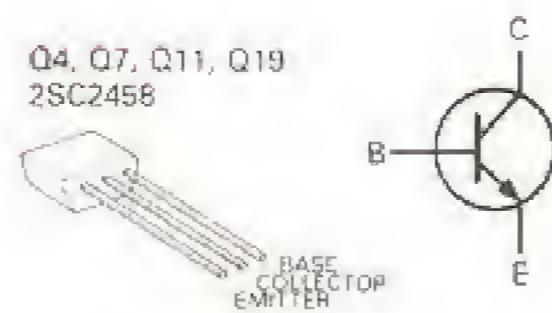
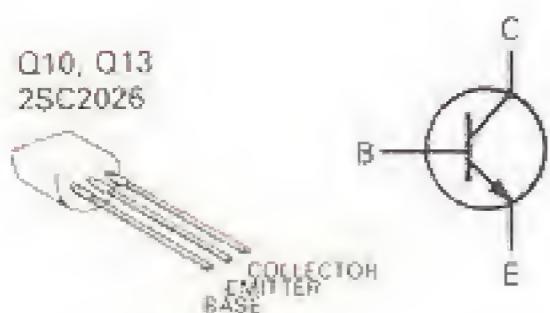
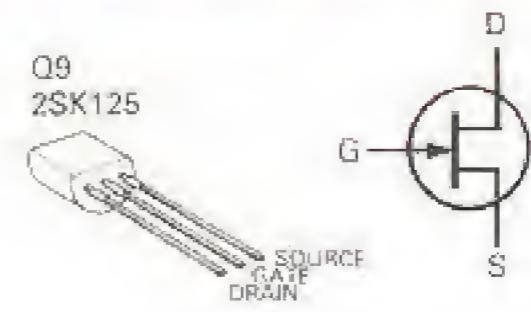
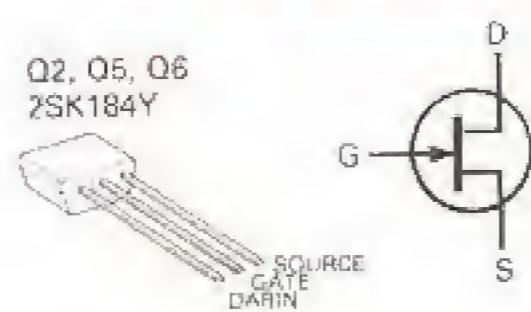
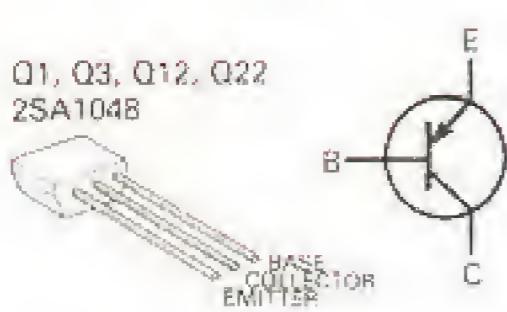
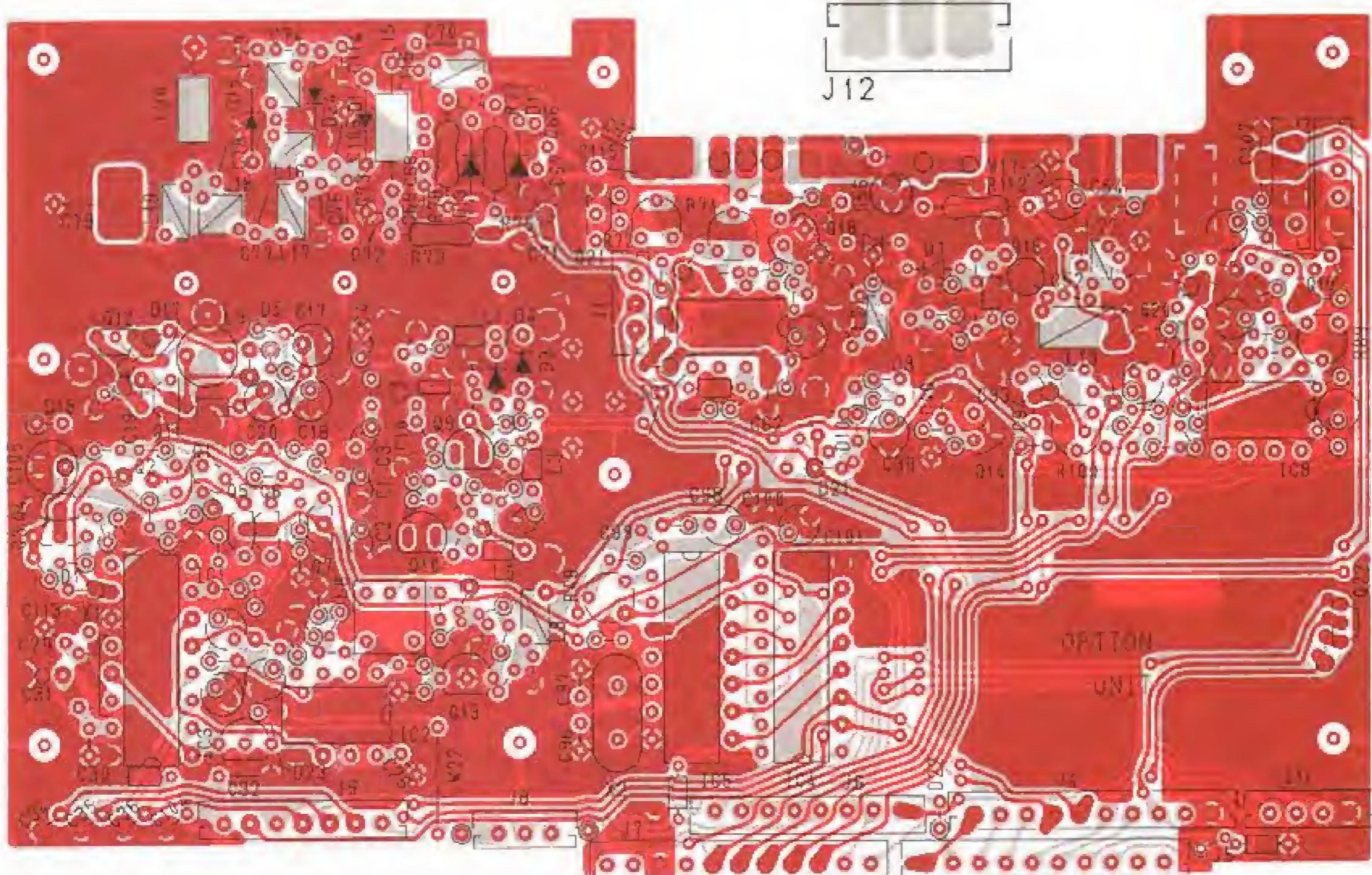
Q10, Q13
2SC2026



Q16
2SC2407

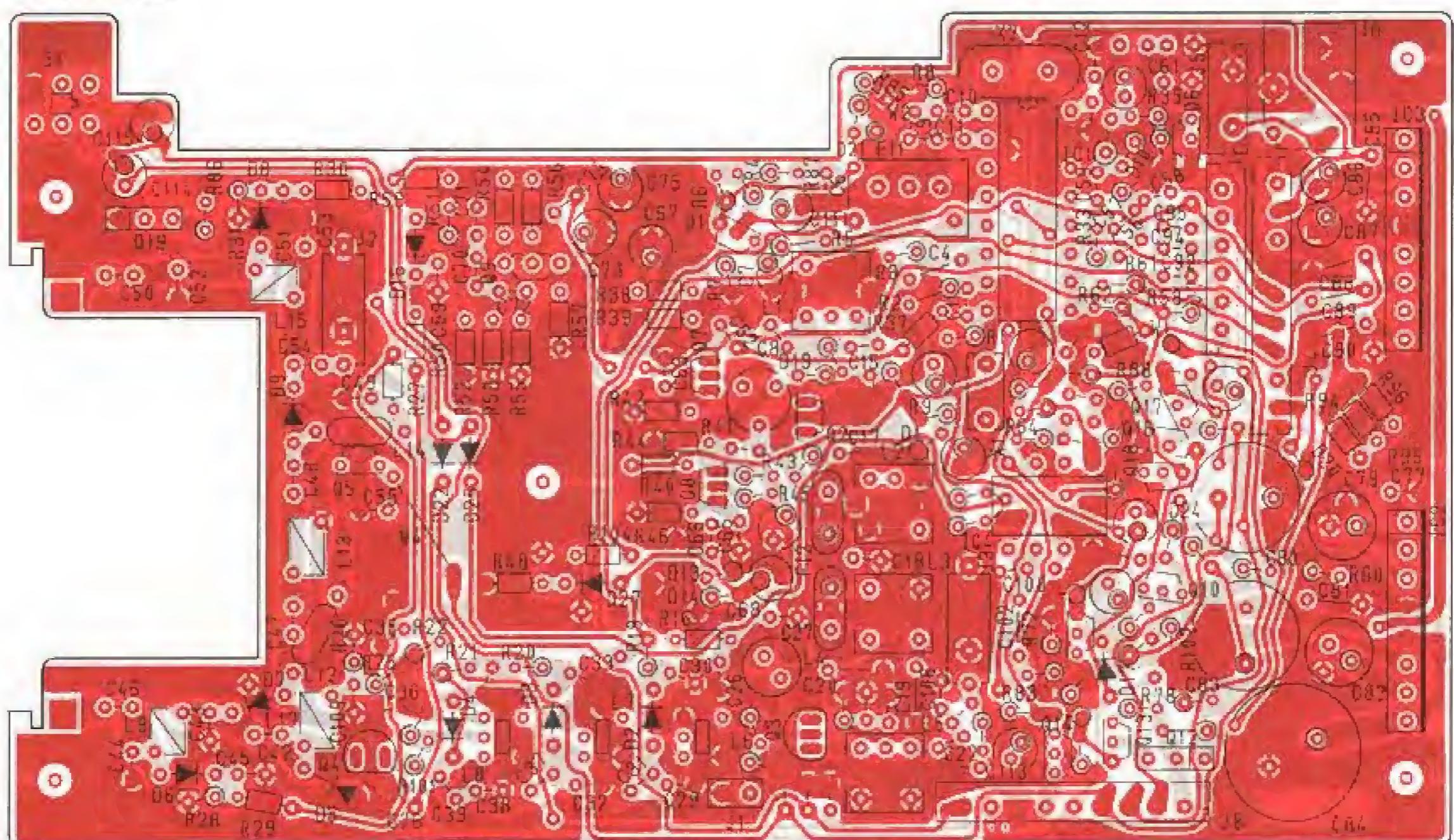


7 - 3 MAIN UNIT (IC-28H VERSIONS)

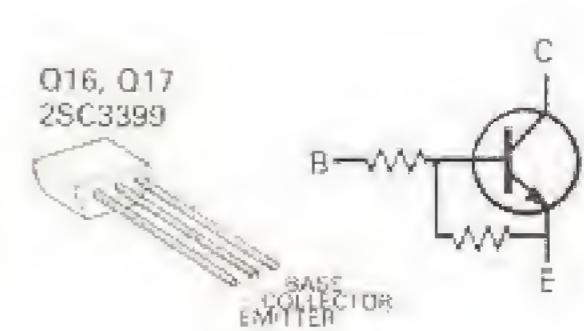
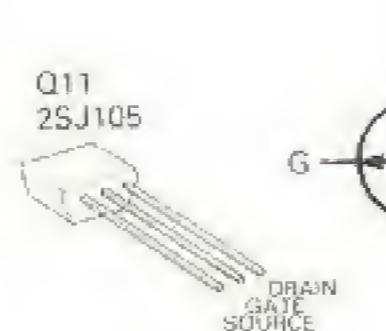
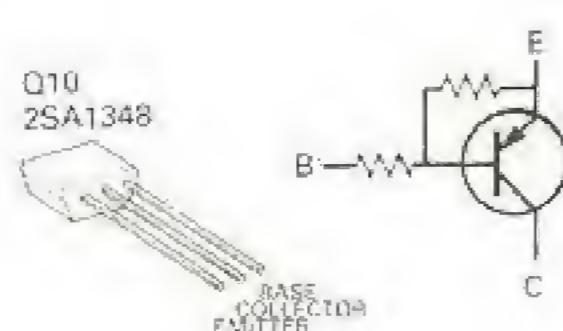
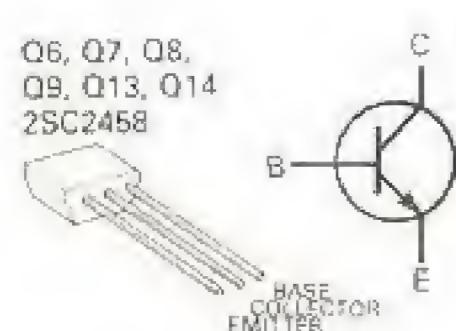
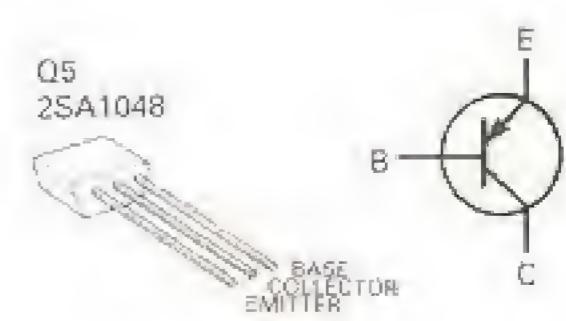
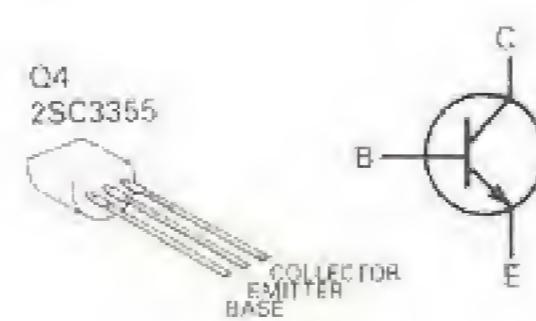
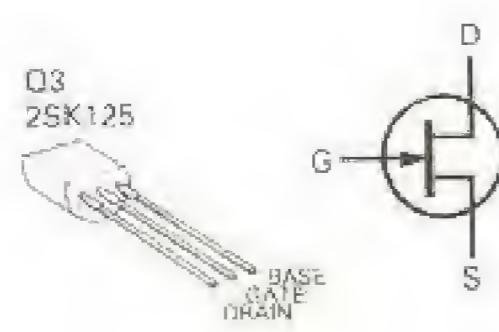
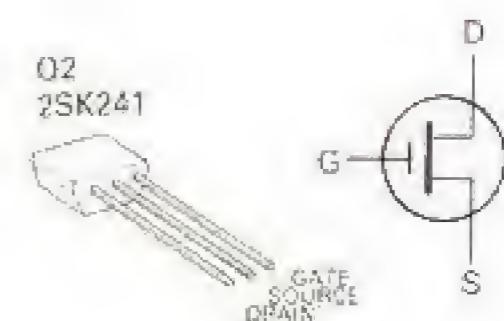
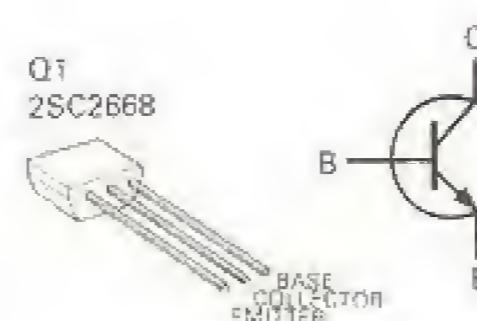
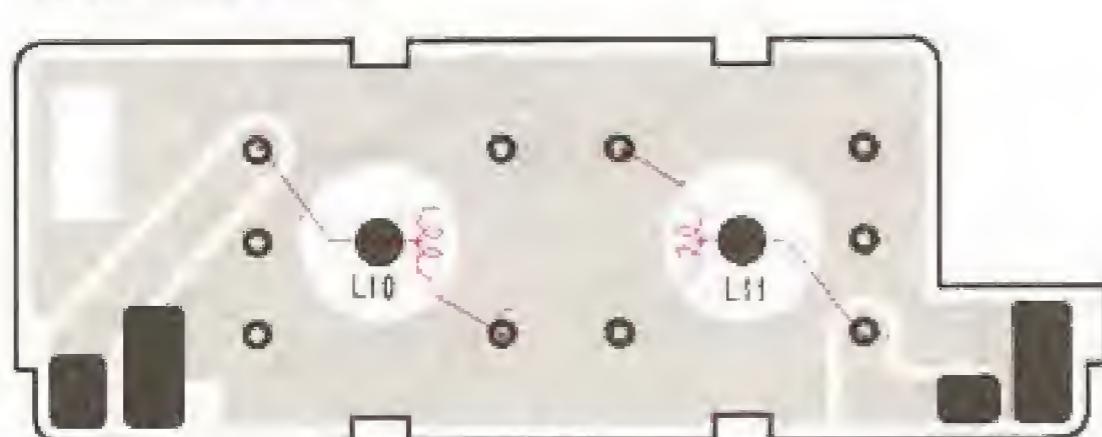


73

7 - 4 RX UNIT

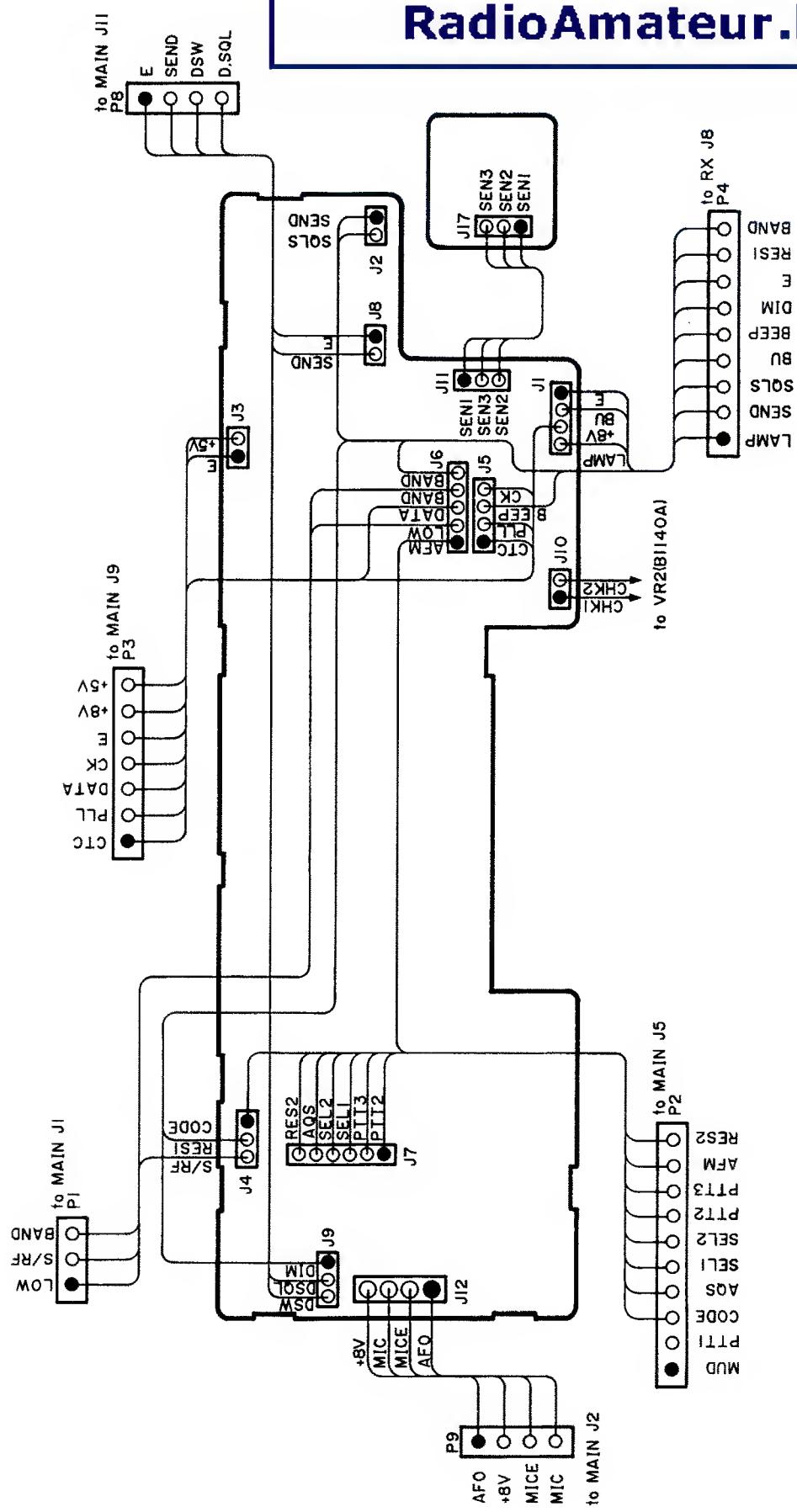


BANDPASS FILTER

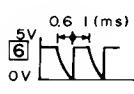
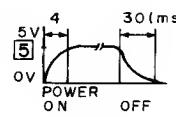
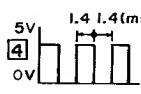
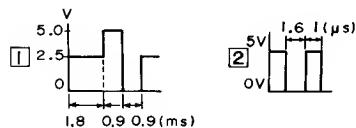
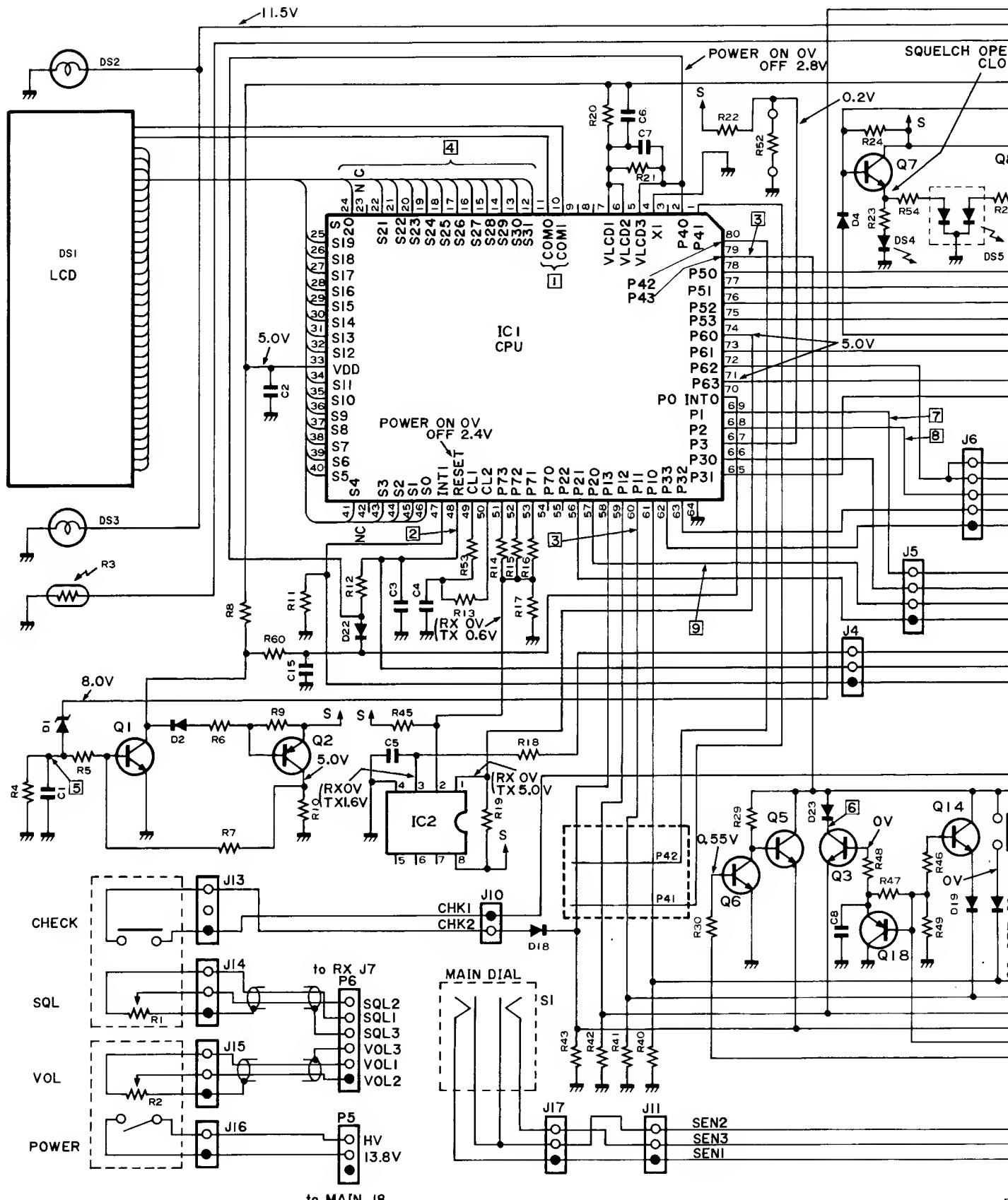


8 - 1 EF UNIT WIRING DIAGRAM

Downloaded by
RadioAmateur.EU



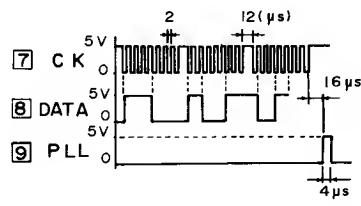
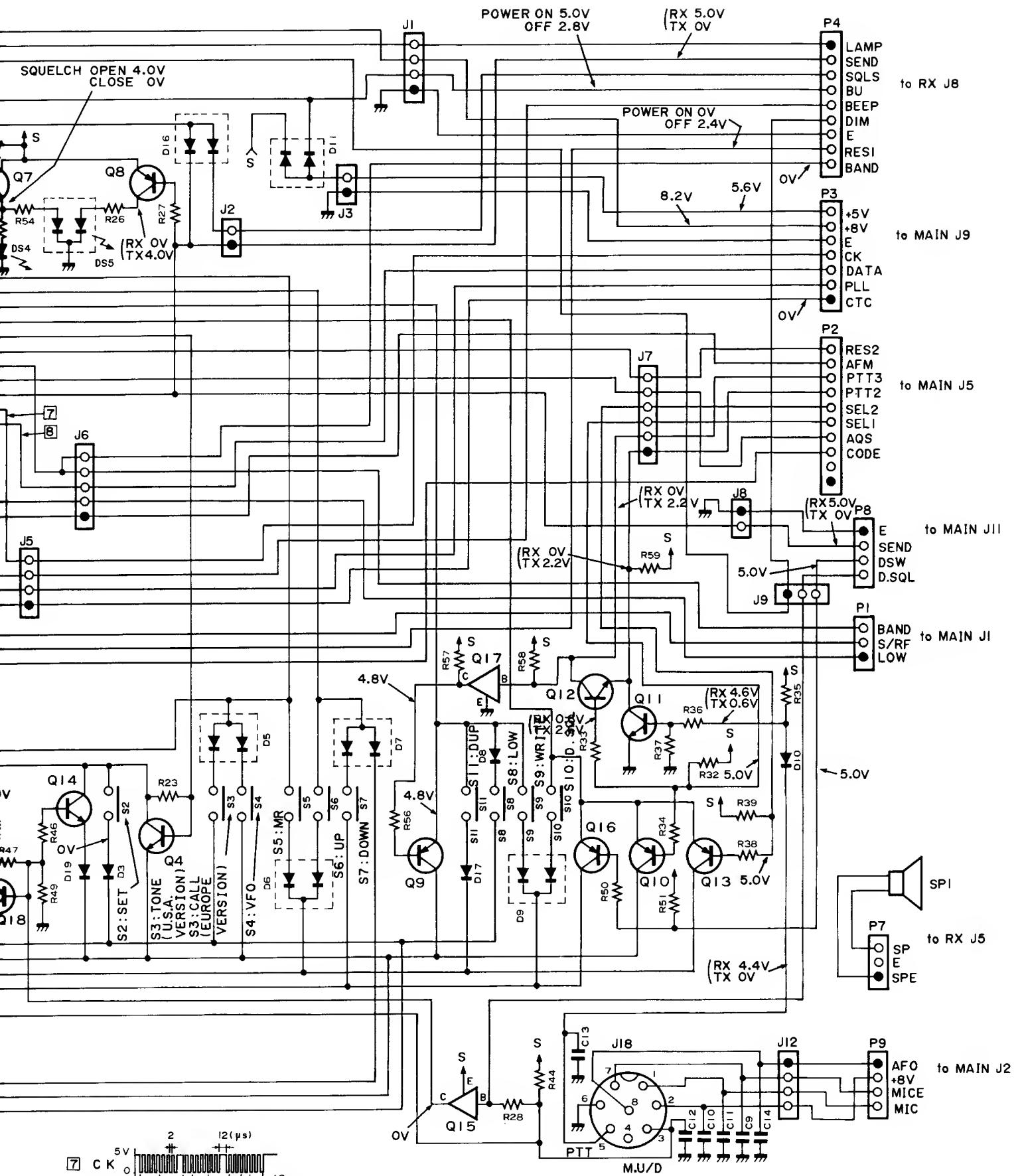
8 - 2 EF UNIT



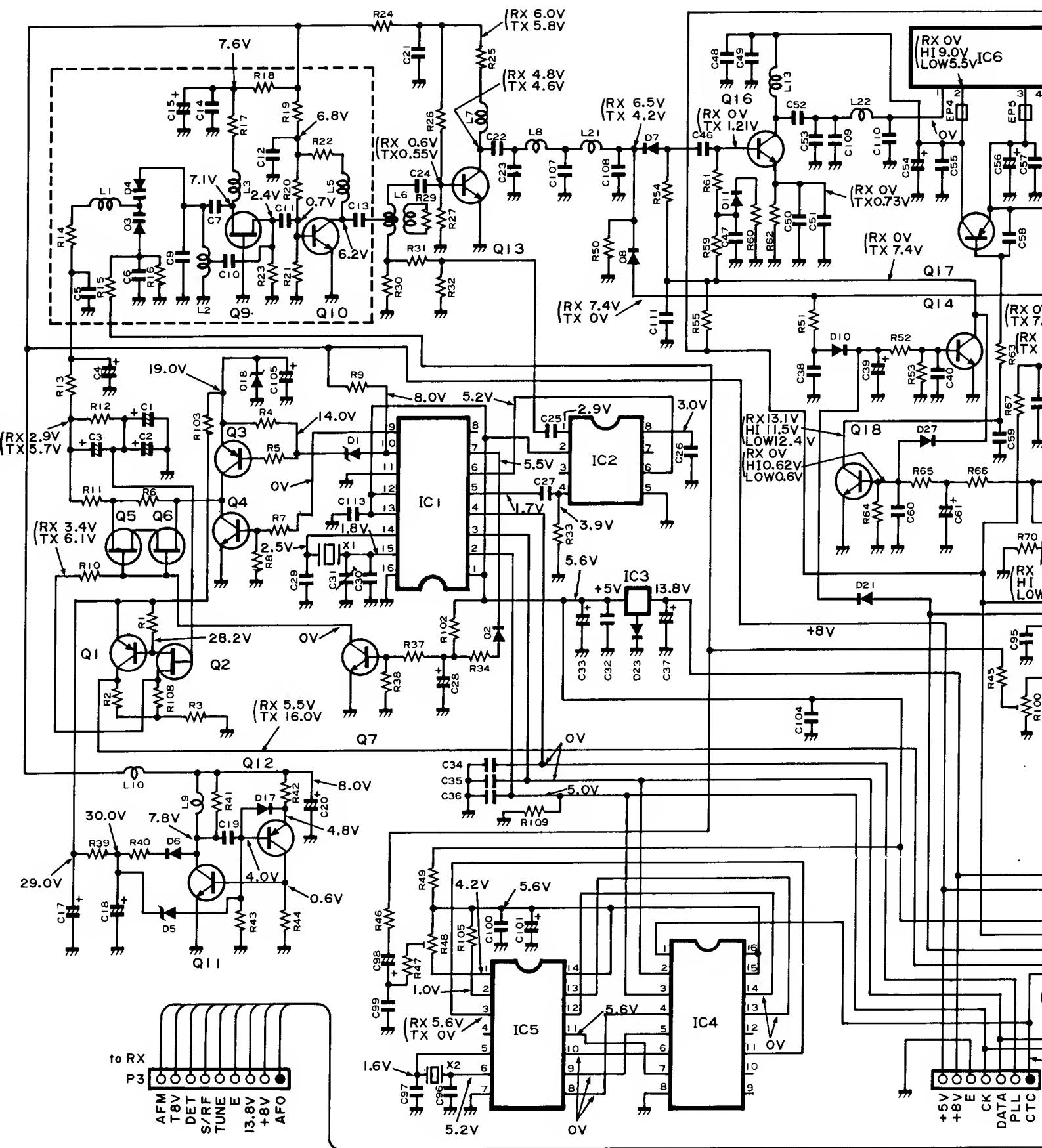
5

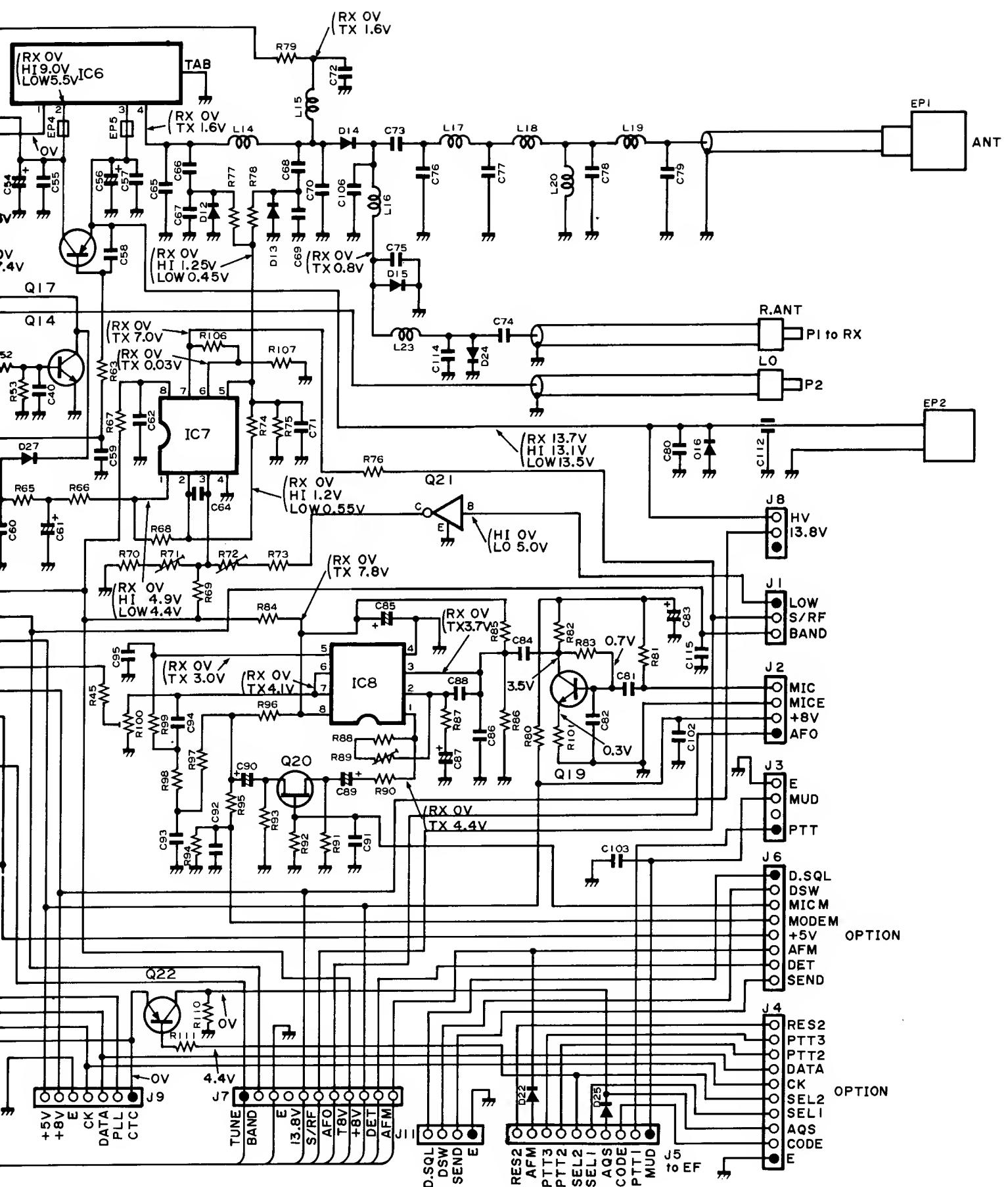
CX

8 DATA

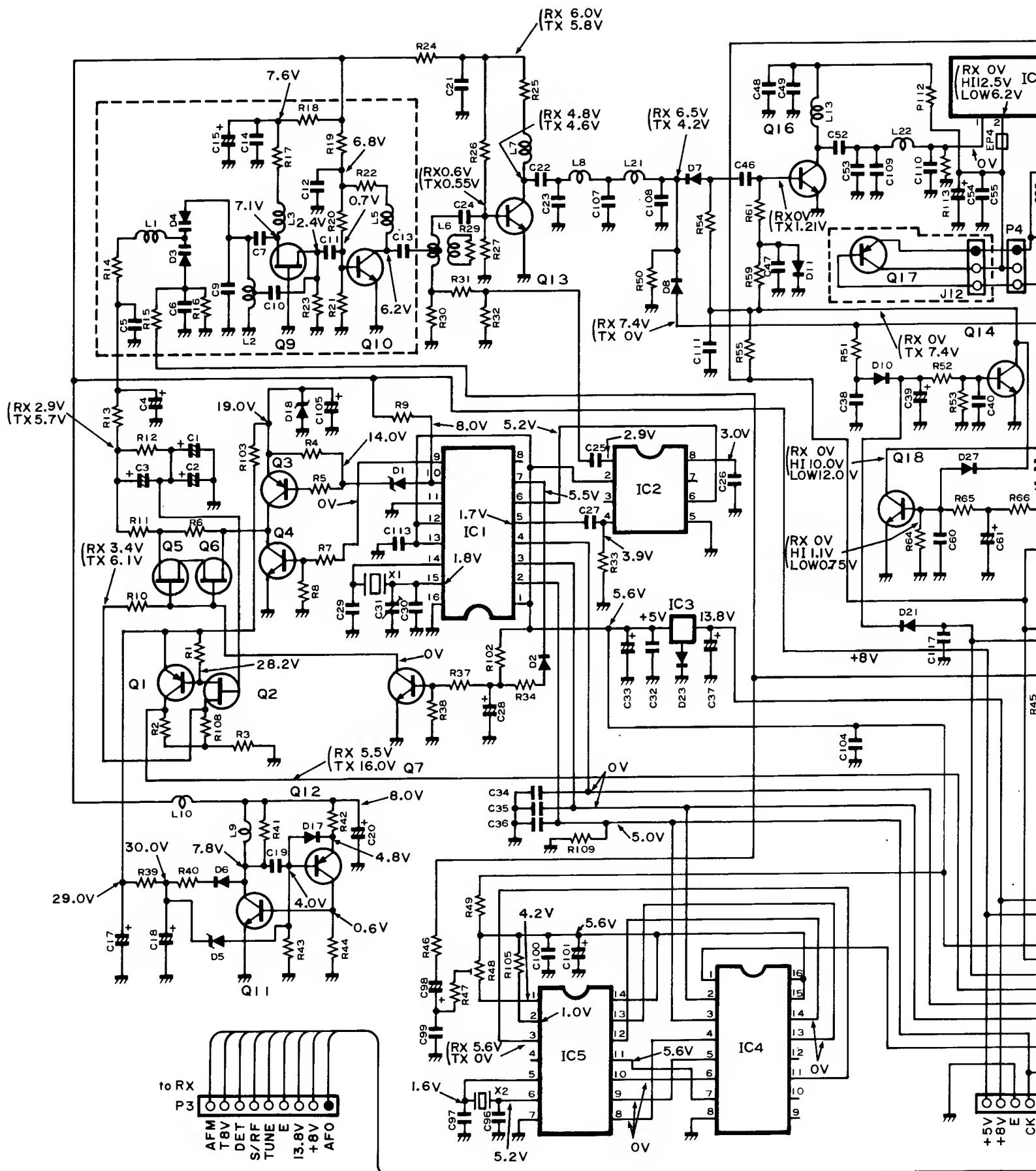


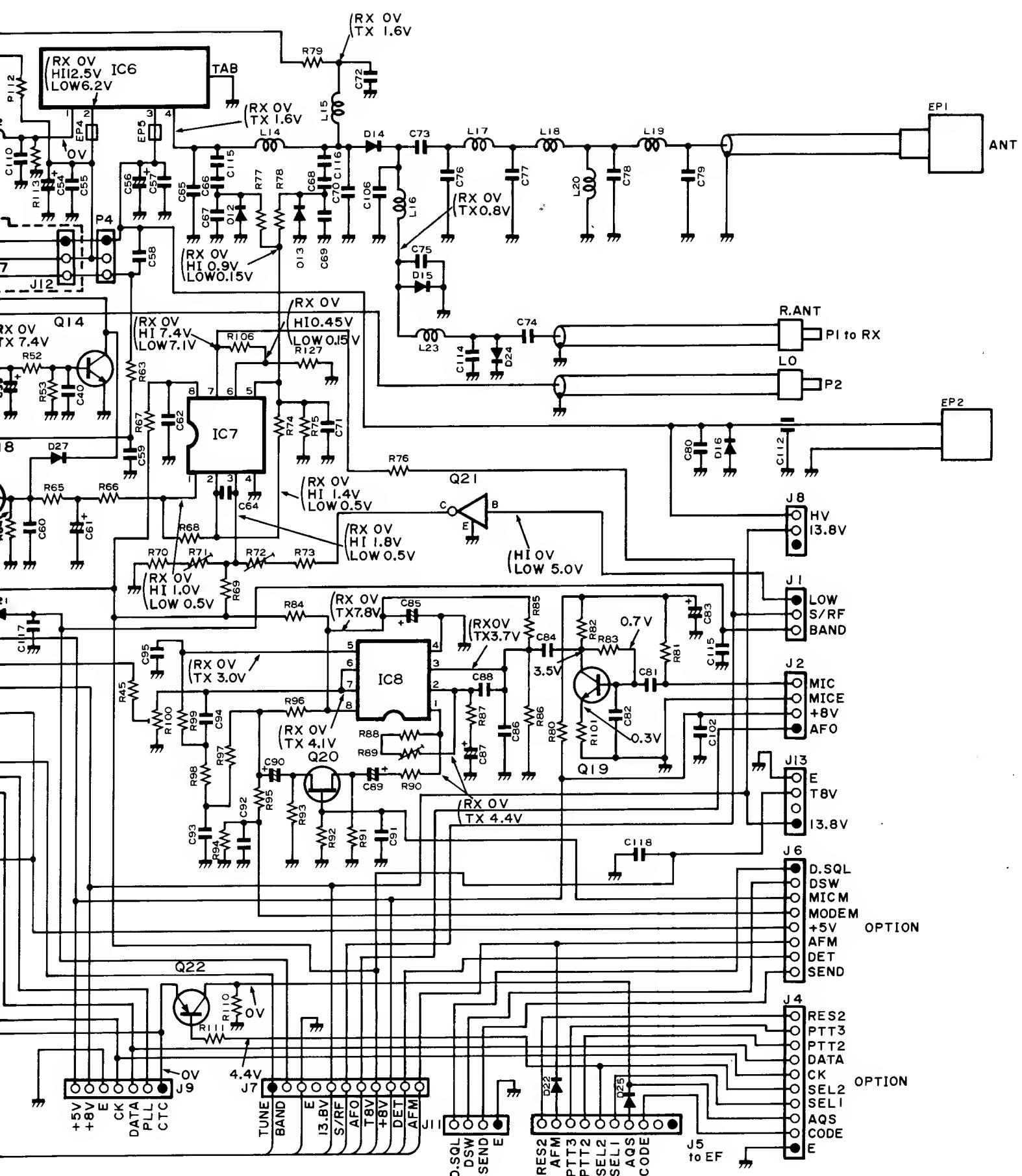
8 - 3 MAIN UNIT (IC-28A/E VERSIONS)

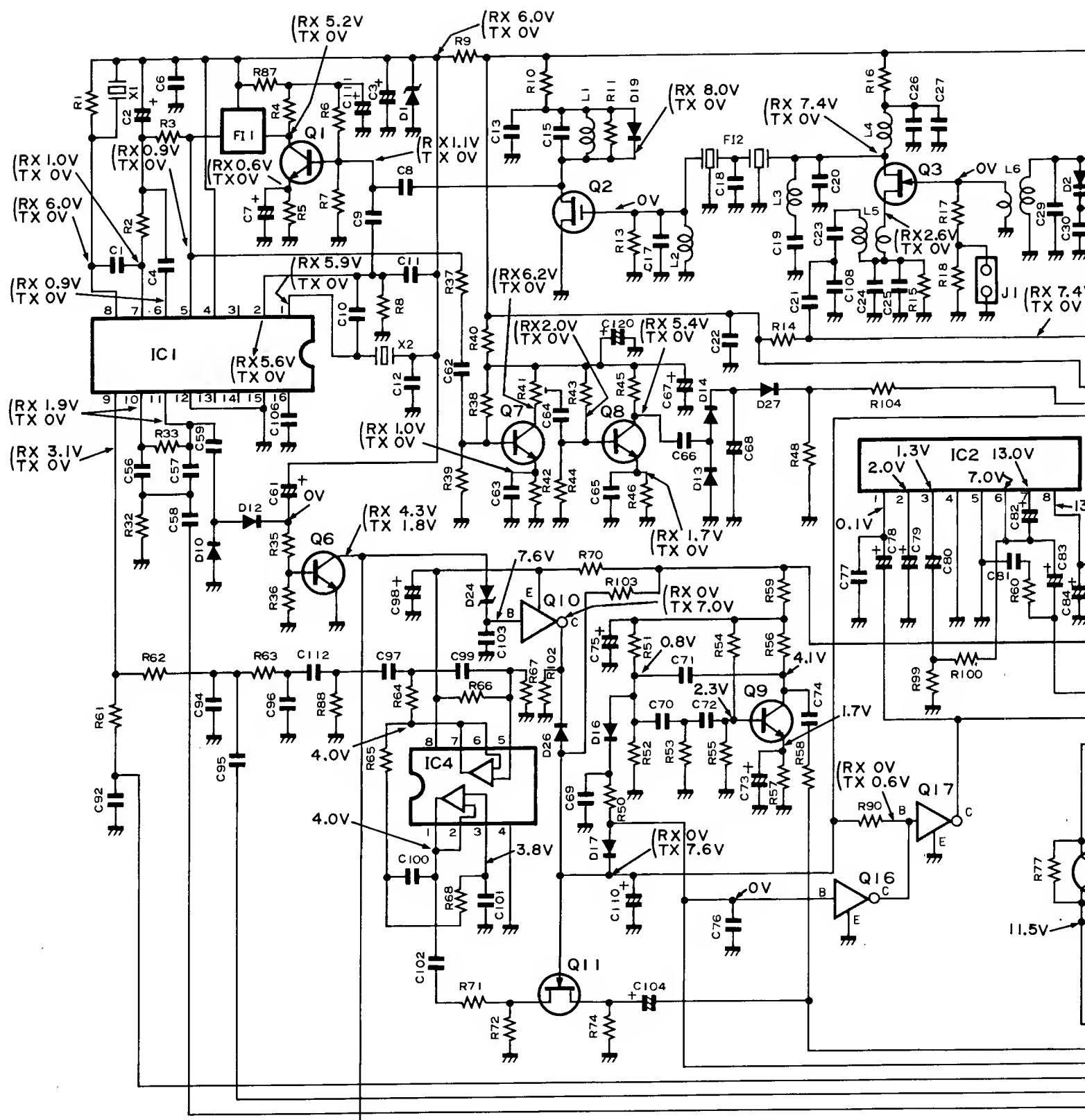


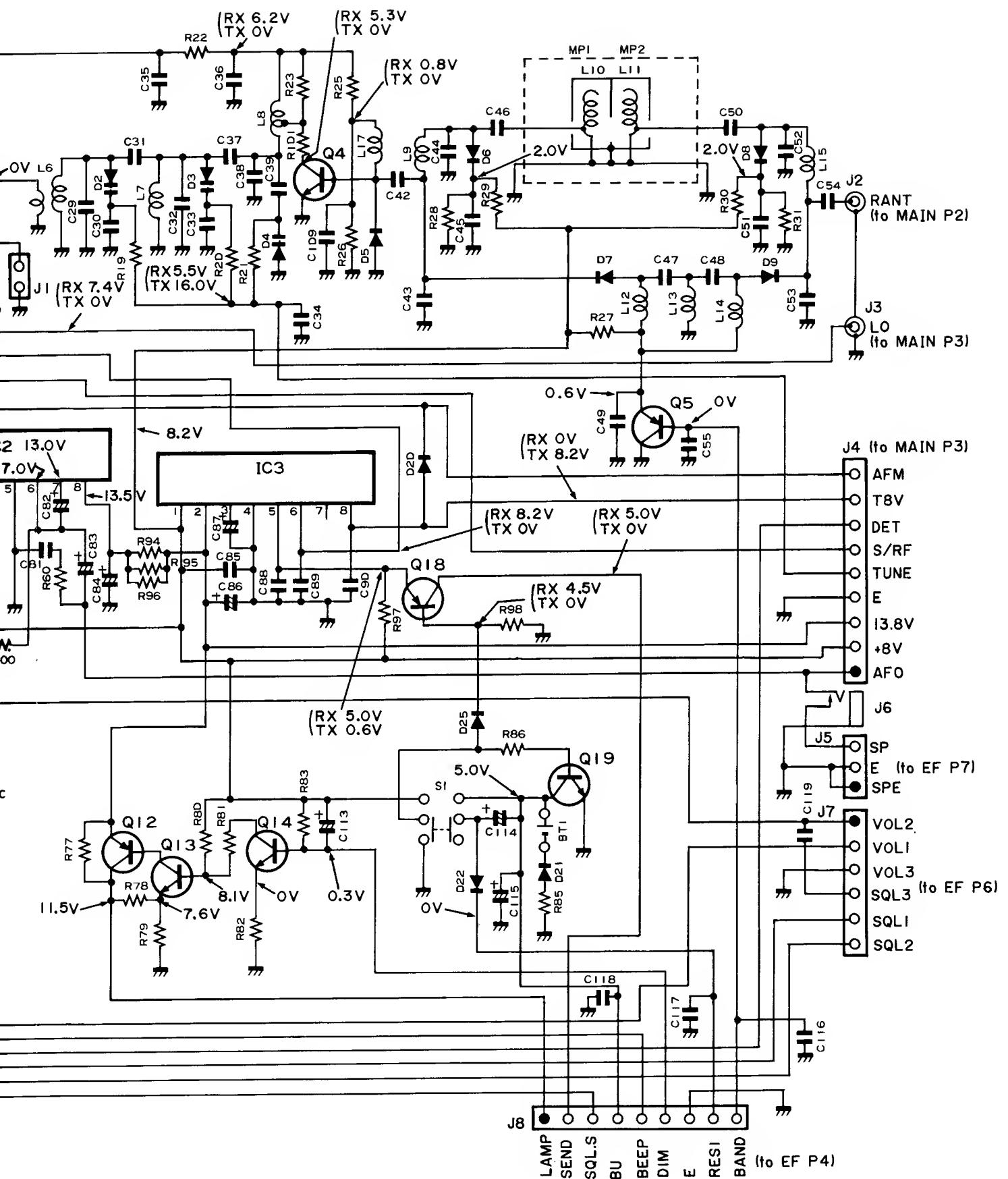


8 - 4 MAIN UNIT (IC-28H VERSIONS)









SECTION 9 TROUBLESHOOTING

The following chart is designed to help you correct problems which are not equipment malfunctions. If you are not able to locate the cause of the problem or to solve it through the use of this chart, contact your nearest authorized ICOM Dealer or Service Center.

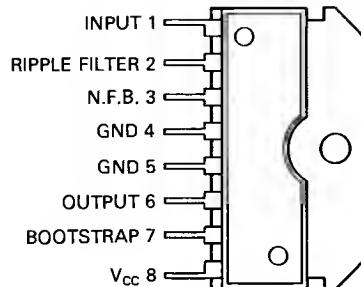
PROBLEM	POSSIBLE CAUSE	SOLUTION
1. Power does not come on when the VOL/PWR CONTROL is pushed ON.	<ul style="list-style-type: none"> Power cable is improperly connected. Power connector is making poor contact. Polarity of the power connection is wrong. Blown fuse. 	<ul style="list-style-type: none"> Carefully reconnect power cable. Check the connector pins. Disconnect the power cable, replace the blown fuse, then reconnect the power cable observing proper polarity. Check for the cause, then replace the fuse.
2. No sound comes from the speaker.	<ul style="list-style-type: none"> Volume setting is too low. SQUELCH CONTROL is set incorrectly. External speaker is connected. 	<ul style="list-style-type: none"> Set volume to an appropriate level. Adjust squelch so the noise from the speaker is just quieted while receiving no signal. Check that the external speaker plug is inserted properly, and that the external speaker cable is not cut.
3. Sensitivity is low and only strong signals are audible.	<ul style="list-style-type: none"> Antenna feedline is cut or short circuited. 	<ul style="list-style-type: none"> Check, and if necessary replace, the feedline.
4. No or low RF output.	<ul style="list-style-type: none"> The LOW position is selected with the HI/LO SWITCH. PTT SWITCH on the microphone is not operating due to poor connection of the MIC CONNECTOR. 	<ul style="list-style-type: none"> Push the HI/LO SWITCH to select the HIGH output power position. Check the connector pins on the MIC CONNECTOR.
5. No modulation of the transmitter.	<ul style="list-style-type: none"> Poor connection of the MIC CONNECTOR. 	<ul style="list-style-type: none"> Check the connector pins on the MIC CONNECTOR.
6. Frequency does not change when the TUNING CONTROL is turned.	<ul style="list-style-type: none"> MEMORY mode is selected. 	<ul style="list-style-type: none"> Select the VFO mode by using the VFO/MR SWITCH.
7. An abnormal, out-of-band frequency is displayed on the front panel DISPLAY.	<ul style="list-style-type: none"> CPU malfunction. Lithium backup battery is exhausted. 	<ul style="list-style-type: none"> Reset the CPU (microcomputer). Refer to SECTION 5-8 in the IC-28A/E/H instruction manual. Take your IC-28A/E/H to an authorized ICOM Dealer or Service Center.
8. Scan functions do not stop even when signals are received.	<ul style="list-style-type: none"> SQL/CHK CONTROL is set incorrectly. 	<ul style="list-style-type: none"> Adjust squelch so the noise from the speaker is just quieted while receiving no signal.
9. Memory channel frequencies change after resetting the CPU.	<ul style="list-style-type: none"> All memories are initialized after the CPU is reset. 	<ul style="list-style-type: none"> Re-program the memory channels after the CPU is reset.

SECTION 10 IC RATINGS

10 - 1 LINEAR ICs

μ PC1241H (AUDIO POWER AMPLIFIER)

PIN CONNECTIONS (Top View)

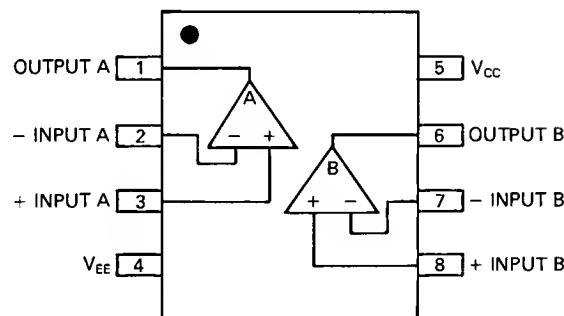


NJM4558D (DUAL LOW NOISE OPERATIONAL AMPLIFIER)

LA6393M (DUAL COMPARATOR)

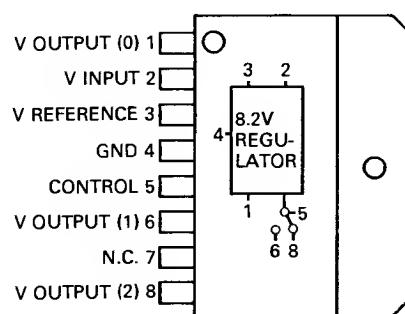
μ PC358C (DUAL DRIVER)

PIN CONNECTIONS (Top View)



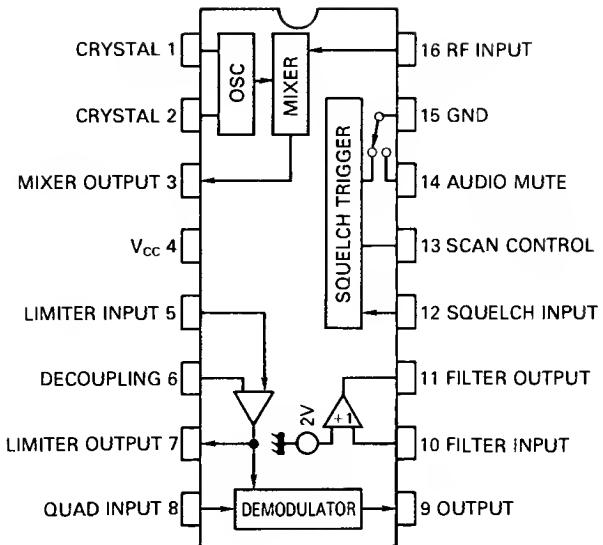
MB3756 (3-OUTPUT 8.2 V VOLTAGE REGULATOR)

PIN CONNECTIONS



MC3357P (NARROW BAND FM IF)

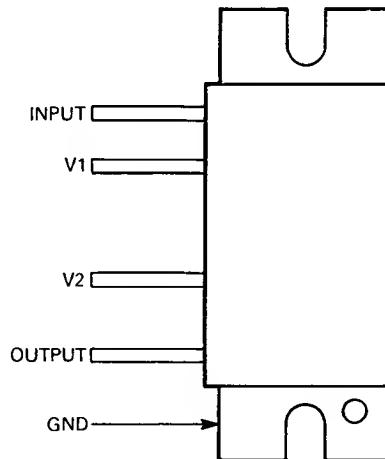
PIN CONNECTIONS (Top View)



SC-1019 (25W VHF RF POWER AMPLIFIER)

SC-1022 (45W VHF RF POWER AMPLIFIER)

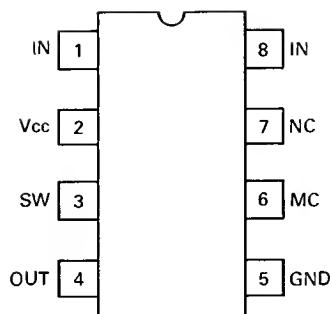
PIN CONNECTIONS



10 - 2 LOGIC ICs

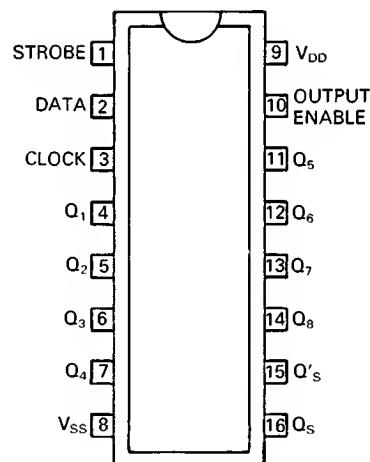
MB504 (HIGH SPEED PRESCALER)

PIN CONNECTIONS (Top View)



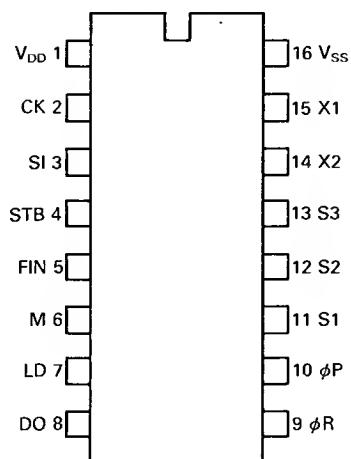
μPD4094 (8-STAGE SHIFT REGISTER)

PIN CONNECTIONS (Top View)



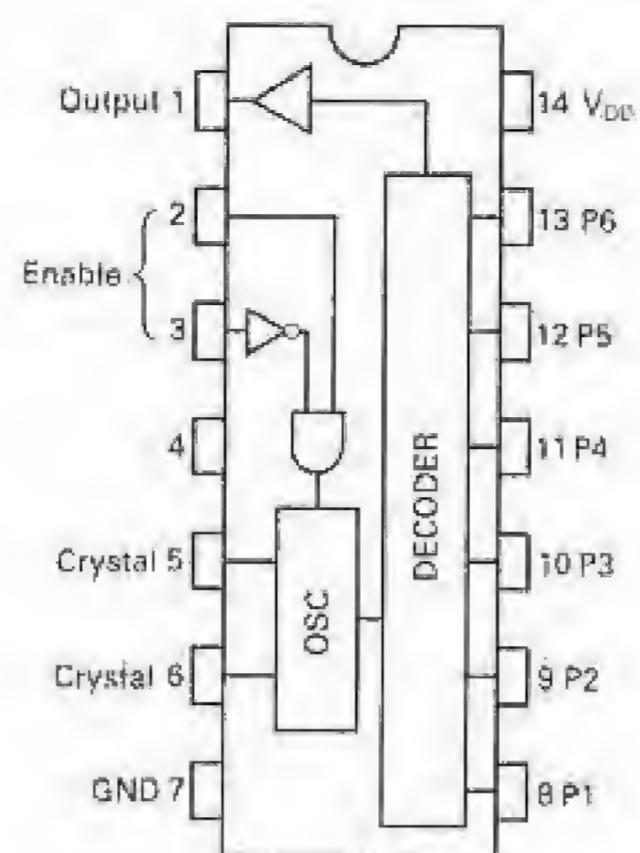
MB87001 (CMOS SERIAL INPUT PLL FREQUENCY SYNTHESIZER)

PIN CONNECTIONS (Top View)



S-7116A (PROGRAMMABLE TONE GENERATOR)

PIN CONNECTIONS (Top View)



PROGRAMMING TABLE

TONE FREQUENCY	P1	P2	P3	P4	P5	P6
57.0	1					
71.9		1				
74.4	1	1				
77.0			1			
79.7	1	1				
82.5		1	1			
85.4	1	1	1			
88.5				1		
91.5	1			1		
94.8		1	1	1		
97.4	1	1	1	1		
100.0			1	1		
103.5	1	1	1	1		
107.2		1	1	1		
110.9	1	1	1	1		
114.8				1		
118.8	1			1		
123.0		1		1		
127.3	1	1		1		
131.8		1	1	1		

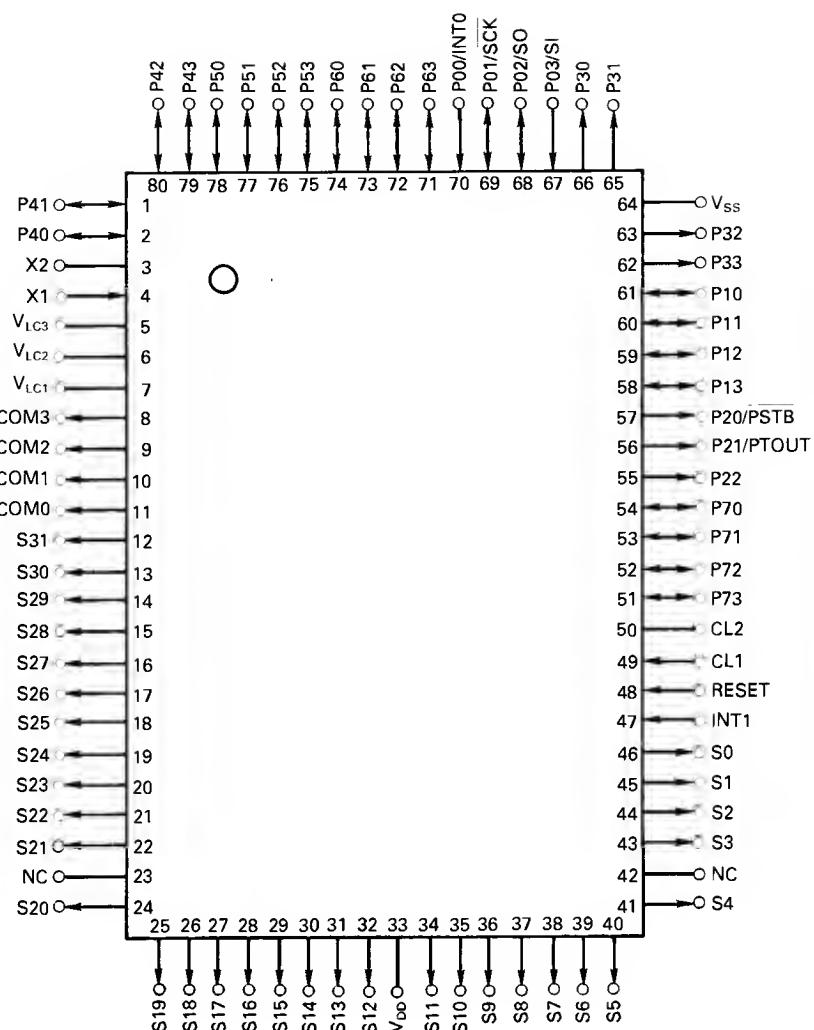
1 : V_{DD}
 Blank : Ground or Open
 Crystal frequency : 3.579545MHz

TONE FREQUENCY	P1	P2	P3	P4	P5	P6
136.5	1		1		1	
141.3		1	1		1	
146.2	1	1	1		1	
151.4				1	1	
156.7	1			1	1	
162.2		1		1	1	
167.9	1	1		1	1	
173.8			1	1	1	
179.9	1		1	1	1	
186.2		1	1	1	1	
192.8	1	1	1	1	1	
203.5						1
210.7	1					1
218.1		1				1
225.7	1	1				1
233.6			1			1
241.8	1		1			1
250.3		1	1			1

TONE FREQUENCY	P1	P2	P3	P4	P5	P6
500	1	1	1			1
600				1		1
700	1			1		1
800		1		1		1
900	1	1		1		1
1000			1	1		1
1600	1		1	1		1
1700		1	1	1		1
1750	1	1	1	1		1
1800					1	1
1300	1				1	1
2000		1			1	1
2200	1	1			1	1
2975			1	1	1	1
2550	1		1	1	1	1
2295		1	1		1	1
2125	1	1	1	1	1	1
1275				1	1	1
1445	1		1	1	1	1

μ PD1514G (MOS DIGITAL IC)

PIN CONNECTIONS (Top View)



SECTION 11 PARTS LIST

NOTE: All parts listed for IC-28A/E are the same in the IC-28H version unless otherwise stated.

11-1 EF UNIT

EF UNIT					
REF. NO.	DESCRIPTION	TYPE (PART NO.)	REF. NO.	DESCRIPTION	TYPE (PART NO.)
IC1	IC	μPD7514G-191-12	R12	Chip	1M
IC2	IC	LA6393M	R13	Chip	100k
Q1	Transistor	2SC2712-Y	R14	Chip	47k
Q2	Transistor	2SA1162-Y	R15	Chip	100k
Q3	Transistor	2SC2712-Y	R16	Chip	220k
Q4	Transistor	2SC2712-Y	R17	Chip	8.2k
Q5	Transistor	2SC2712-Y	R18	Chip	100k
Q6	Transistor	2SC2712-Y	R19	Chip	100k
Q7	Transistor	2SC2712-Y	R20	Chip	270k
Q8	Transistor	2SA1162-Y	R21	Chip	270k
Q9	Transistor	2SA1162-Y	R22	Chip	100k
Q10	Transistor	2SA1162-Y	R23	Chip	100k
Q11	Transistor	2SC2712-Y	R24	Chip	3.3k
Q12	Transistor	2SC2712-Y	R26	Chip	330
Q13	Transistor	2SA1162-Y	R27	Chip	22k
Q14	Transistor	2SC2712-Y	R28	Chip	100k
Q15	Transistor	2SA1341	R29	Chip	100k
Q16	Transistor	2SA1162-Y	R30	Chip	100k
Q17	Transistor	2SC3395	R32	Chip	10k
Q18	Transistor	2SA1162-Y	R33	Chip	470k
			R34	Chip	100k
			R35	Chip	2.2k
D1	Zener	RD5.6M B2	R36	Chip	22k
D2	Diode	1SS190	R37	Chip	10k
D3	Diode	1SS190	R38	Chip	100k
D4	Diode	1SS193	R39	Chip	100k
D5	Diode	1SS181	R40	Chip	100k
D6	Diode	1SS184	R41	Chip	100k
D7	Diode	1SS181	R42	Chip	100k
D8	Diode	1SS190	R43	Chip	100k
D9	Diode	1SS184	R44	Chip	1k
D10	Diode	1SS193	R45	Chip	220k
D11	Diode	1SS181	R46	Chip	470k
D12	Diode	1SS181	R47	Chip	220k
D14	Diode	1SS181 (#01)	R48	Chip	1M
D14	Diode	1SS187 (#03, #04)	R49	Chip	10k
D15	Diode	1SS190 (#03, #05)	R50	Chip	100k
D16	Diode	1SS181	R51	Chip	100k
D17	Diode	1SS190	R52	Resistor	4.7k
D18	Diode	1SS190	R53	Chip	3.3k
D19	Diode	1SS190	R54	Chip	150
D22	Diode	1SS193	R56	Chip	100k
D23	Diode	1SS193	R57	Chip	470k
			R58	Chip	100k
R1	Variable	RK0941114 (10KB)	R59	Chip	470k
R2	Variable	RK9A12 (10KA)	R60	Chip	56k
R3	CDS	MPY-43C79	C1	Monolithic	0.1
R4	Chip	10k MCR10	C2	Monolithic	0.1
R5	Chip	10k MCR10	C3	Monolithic	0.001
R6	Chip	220k MCR10	C4	Monolithic	33P
R7	Chip	270k MCR10	C5	Monolithic	0.01
R8	Chip	10k MCR10	C6	Monolithic	0.01
R9	Chip	100k MCR10	C7	Monolithic	0.01
R10	Chip	10k MCR10	C8	Monolithic	0.1
R11	Chip	100k MCR10			GRM40 F

EF UNIT**11 - 2 MAIN UNIT**

REF. NO.	DESCRIPTION	TYPE (PART NO.)	REF. NO.	DESCRIPTION	TYPE (PART NO.)	
C9	Monolithic	0.001	GRM40	IC1	IC	MB87001P-G
C10	Monolithic	0.001	GRM40	IC2	IC	MB504P-G
C11	Monolithic	0.001	GRM40	IC3	IC	μA78L05AWC
C12	Monolithic	0.001	GRM40	IC4	IC	μPD4094 (#01)
C13	Monolithic	0.001	GRM40	IC5	IC	S-7116A (#01)
C14	Monolithic	0.001	GRM40	IC6	IC	SC-1019
C15	Monolithic	0.1	GRM40 F	IC6	IC	SC-1022 (IC-28H version)
				IC7	IC	μPC358C
J1	Connector	PD09A04M		IC8	IC	NJM4558D
J2	Connector	PD09A02M				
J3	Connector	PD09A02M	Q1	Transistor	2SA1048-GR	
J4	Connector	PD09A03M	Q2	FET	2SK184-Y	
J5	Connector	PD09A04M	Q3	Transistor	2SA1048-GR	
J6	Connector	PD09A05M	Q4	Transistor	2SC2458-GR	
J7	Connector	PD09A06M	Q5	FET	2SK184-Y	
J8	Connector	PD09A02M	Q6	FET	2SK184-Y	
J9	Connector	PD09A03M	Q7	Transistor	2SC2458-GR	
J10	Connector	PD09A02M	Q9	FET	2SK125	
J11	Connector	PD09A03M	Q10	Transistor	2SC2026	
J12	Connector	TLB-P04H-B1	Q11	Transistor	2SC2458-GR	
J13	Connector	PD09A03M	Q12	Transistor	2SA1048-GR	
J14	Connector	TLB-P03H-B1	Q13	Transistor	2SC2026	
J15	Connector	TLB-P03H-B1	Q14	Transistor	2SC2458-GR	
J16	Connector	PD09A02M	Q16	Transistor	2SC2407	
J17	Connector	TLB-P03H-B1	Q16	Transistor	TRF559 (IC-28H version)	
J18	Connector	8S-S-E	Q17	Transistor	2SA1359-Y	
			Q17	Transistor	2SB1019-O/Y (IC-28H version)	
P1	Connector	EHR-03	Q18	Transistor	2SC2458-GR	
P2	Connector	EHR-10	Q18	Transistor	2SC1645-B (IC-28H version)	
P3	Connector	EHR-07	Q19	Transistor	2SC2458L-G	
P4	Connector	EHR-09	Q20	FET	2SJ105-GR	
P5	Connector	EHR-03	Q21	Transistor	2SC3399	
P6	Connector	EHR-06	Q22	Transistor	2SA1048-GR	
P7	Connector	EHR-03				
P8	Connector	EHR-04	D1	Zener	RD15E B2	
P9	Connector	EHR-04	D2	Diode	1SS133	
			D3	Varicap	1SV50E	
DS1	LCD	LP234-A	D4	Varicap	1SV50E	
DS2	Lamp	HRS-7219A-G40	D5	Zener	RD30E B2	
DS3	Lamp	HRS-7219A-G40	D6	Diode	1S953	
DS5	LED	GL9ND2	D7	Diode	1SS216	
			D8	Diode	1SS216	
S1	Rotary Encoder	SRBM1L011A	D10	Diode	1SS133	
S2	Switch	SKHLAB 064A	D11	Diode	1SS53	
S3	Switch	SKHLAB 064A	D12	Diode	1SS97	
S4	Switch	SKHLAB 064A	D13	Diode	1SS97	
S5	Switch	SKHLAB 064A	D14	Diode	MI308	
S6	Switch	SKHLAB 064A	D14	Diode	MI407 (IC-28H version)	
S7	Switch	SKHLAB 064A	D15	Diode	MI308	
S8	Switch	SKHLAB 064A	D16	Diode	15CD11	
S9	Switch	SKHLAB 064A	D17	Diode	1SS133	
S10	Switch	SKHLAB 064A	D18	Zener	RD20E B2	
S11	Switch	SKHLAB 064A	D21	Diode	1SS133	
			D22	Diode	1SS133	
SP1	Speaker	57S38-1	D23	Diode	1SS133	
			D24	Diode	MI308	
EP1	P.C.B.	B-1138B	D25	Diode	1SS133	
EP2	P.C.B.	B-1140A	D27	Diode	1S953 (IC-28H version)	
EP3	P.C.B.	B-1229				
EP5	Rubber Conductor	SS TYPE 48.5×8.5×3	X1	Crystal	CR106 (#01, #04)	
EP6	P.C.B.	B-1175B	X1	Crystal	CR107 (#03, #05)	
			X2	Crystal	RF4A3FAANKD (#01)	
			L1	Coil	LAL02KR 3R3K	

MAIN UNIT
MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	REF. NO.	DESCRIPTION	TYPE (PART NO.)
L2	Coil	LB-167	R45	Resistor	15k ELR20
L3	Coil	LAL02KR 3R3K	R46	Resistor	47k ELR20 (#01)
L5	Coil	LAL02KR 3R3K	R47	Resistor	47k ELR20 (#01)
L6	Coil	LR-116	R48	Trimmer	RHB0CS42BA 47k (#01)
L7	Coil	LAL03NA 3R3K	R49	Resistor	10 R20 (#01)
L8	Coil	LA-244	R50	Resistor	4.7k R20
L9	Coil	LW-30	R51	Resistor	1k ELR20
L10	Coil	LAL03NA 102K	R52	Resistor	10k ELR20
L13	Coil	LA-246	R53	Resistor	10k ELR20
L13	Coil	LA-254 (IC-28H version)	R54	Resistor	2.2k R20
L14	Coil	LA-234	R55	Resistor	390 R20
L14	Coil	LA-244 (IC-28H version)	R59	Resistor	2.2k R20
L15	Coil	LW-19	R60	Resistor	330 ELR20 (IC-28A/E versions only)
L16	Coil	LA-235	R61	Resistor	47 ELR20
L17	Coil	LA-244	R62	Resistor	10 ELR20 (IC-28A/E versions only)
L18	Coil	LA-236	R63	Resistor	330 ELR20
L19	Coil	LA-244	R63	Resistor	220 R50 (IC-28H version)
L20	Coil	LW-19	R64	Resistor	10k ELR20
L21	Coil	LA-233	R64	Resistor	33k ELR20 (IC-28H version)
L22	Coil	LA-233	R65	Resistor	47k ELR20
L22	Coil	LA-235 (IC-28H version)	R66	Resistor	10k ELR20
L23	Coil	LA-235	R67	Resistor	100 ELR20
R1	Resistor	220k ELR20	R68	Resistor	820k ELR20
R2	Resistor	150k ELR20	R68	Resistor	2.2M ELR20 (IC-28H version)
R3	Resistor	100k ELR20	R69	Resistor	15k ELR20
R4	Resistor	330k ELR20	R70	Resistor	1.2k ELR20
R5	Resistor	27k ELR20	R70	Resistor	2.2k ELR20 (IC-28H version)
R6	Resistor	10k ELR20	R71	Trimmer	RHMOAJ304A 3.3k
R7	Resistor	47k ELR20	R72	Trimmer	RHMOAJ305A 2.2k
R8	Resistor	100k ELR20	R73	Resistor	390 ELR20
R9	Resistor	10k ELR20	R73	Resistor	47 ELR20 (IC-28H version)
R10	Resistor	2.2M ELR20	R74	Resistor	56k ELR20
R11	Resistor	470 ELR20	R75	Resistor	4.7k ELR20
R12	Resistor	270 R20	R76	Resistor	100k R20
R13	Resistor	2.2k ELR20	R77	Resistor	4.7k R20
R14	Resistor	470 ELR20	R77	Resistor	4.7k CRB25FX (IC-28H version)
R15	Resistor	2.7k ELR20	R78	Resistor	4.7k R20
R16	Resistor	470 ELR20	R78	Resistor	4.7k CRB25FX (IC-28H version)
R17	Resistor	47 ELR20	R79	Resistor	100 R50
R18	Resistor	47 ELR20	R79	Resistor	68 R50 (IC-28H version)
R19	Resistor	100 ELR20	R80	Resistor	100 ELR20
R20	Resistor	4.7k ELR20	R81	Resistor	1k ELR20
R21	Resistor	680 ELR20	R82	Resistor	5.6k ELR20
R22	Resistor	47 ELR20	R83	Resistor	1.2M ELR20
R23	Resistor	220 ELR20	R84	Resistor	100 ELR20
R24	Resistor	100 ELR20	R85	Resistor	220k ELR20
R25	Resistor	47 ELR20	R86	Resistor	270k ELR20
R26	Resistor	4.7k ELR20	R87	Resistor	100 ELR20
R27	Resistor	680 ELR20	R88	Resistor	1.5k ELR20
R29	Resistor	47 ELR20	R89	Trimmer	RHB0C151XA 100k
R30	Resistor	270 ELR20	R90	Resistor	56k ELR20
R31	Resistor	18 ELR20	R91	Resistor	5.6k ELR20
R32	Resistor	270 ELR20	R92	Resistor	100k ELR20
R33	Resistor	4.7k ELR20	R93	Resistor	33k ELR20
R34	Resistor	4.7k ELR20	R94	Resistor	100k ELR20
R37	Resistor	270k ELR20	R95	Resistor	47k ELR20
R38	Resistor	100k ELR20	R96	Resistor	150k ELR20
R39	Resistor	470 ELR20	R97	Resistor	82k ELR20
R40	Resistor	470 ELR20	R98	Resistor	82k ELR20
R41	Resistor	10k R20	R99	Resistor	82k ELR20
R42	Resistor	15k ELR20	R100	Trimmer	RHB0C1431A 10k
R43	Resistor	68k ELR20	R101	Resistor	330 ELR20
R44	Resistor	2.2k ELR20			

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)
L11	Coil	LB-50A
L12	Coil	LAL03NA 3R3k
L13	Coil	LA-244
L14	Coil	LAL03NA 3R3k
L15	Coil	LA-235
L17	Coil	LA-245
R1	Resistor	1.5k ELR20
R2	Resistor	47k ELR20
R3	Resistor	1.5k ELR20
R4	Resistor	1.5k ELR20
R5	Resistor	1k ELR20
R6	Resistor	56k ELR20
R7	Resistor	18k ELR20
R8	Resistor	22k ELR20
R9	Resistor	100 ELR20
R10	Resistor	100 ELR20
R11	Resistor	10k ELR20
R13	Resistor	2.2k ELR20
R14	Resistor	470 ELR20
R15	Resistor	330 ELR20
R16	Resistor	100 R20
R17	Resistor	1.5k ELR20
R18	Resistor	1.5k ELR20
R19	Resistor	100k ELR20
R20	Resistor	100k ELR20
R21	Resistor	100k ELR20
R22	Resistor	68 ELR20
R23	Resistor	470 ELR20
R25	Resistor	820 ELR20
R26	Resistor	120 ELR20
R27	Resistor	3.3k R20
R28	Resistor	3.9k ELR20
R29	Resistor	12k R20
R30	Resistor	12k R20
R31	Resistor	3.9k ELR20
R32	Resistor	5.6k ELR20
R33	Resistor	330k ELR20
R35	Resistor	100k ELR20
R36	Resistor	100k ELR20
R37	Resistor	27k R20
R38	Resistor	180k R20
R39	Resistor	47k R20
R40	Resistor	100 R20
R41	Trimmer	RHB0CS32UA 4.7k
R42	Resistor	2.7k R20
R43	Resistor	100k ELR20
R44	Resistor	47k R20
R45	Resistor	2.7k ELR20
R46	Resistor	1k R20
R48	Resistor	12k R20
R50	Resistor	10k R20
R51	Resistor	100k ELR20
R52	Resistor	27k R20
R53	Resistor	27k R20
R54	Resistor	68k R20
R55	Resistor	27k R20
R56	Resistor	22k R20
R57	Resistor	10k R20
R58	Resistor	470k ELR20
R59	Resistor	100 R20
R60	Resistor	2.2 ELR20
R61	Resistor	470 ELR20
R62	Resistor	470 ELR20

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)
R63	Resistor	27k R20
R64	Resistor	5.6k ELR20
R65	Resistor	12k ELR20
R66	Resistor	1.2M ELR20
R67	Resistor	1.2M ELR20
R68	Resistor	12k ELR20
R70	Resistor	100 ELR20
R71	Resistor	2.7k ELR20
R72	Resistor	4.7k ELR20
R74	Resistor	10k ELR20
R77	Resistor	100 R50
R78	Resistor	1.5k ELR20
R79	Resistor	2.7k ELR20
R80	Resistor	3.3k ELR20
R81	Resistor	8.2k ELR20
R82	Resistor	4.7k ELR20
R83	Resistor	220k ELR20
R85	Resistor	220k ELR20
R86	Resistor	1.5k ELR20
R87	Resistor	100 ELR20
R88	Resistor	27k ELR20
R90	Resistor	220k ELR20
R94	Resistor	1 R20
R95	Resistor	1 R20
R96	Resistor	1 R20
R97	Resistor	100k ELR20
R98	Resistor	100k ELR20
R99	Resistor	3.3 ELR20
R100	Resistor	1k ELR20
R101	Resistor	47 ELR20
R102	Resistor	4.7k ELR20
R103	Resistor	100k ELR20
R104	Resistor	1k R20
C1	Ceramic	82P 50V
C2	Electrolytic	0.1 50V MS7
C3	Electrolytic	4.7 25V MS7
C4	Barrier	0.1 16V
C6	Barrier	0.01 25V
C7	Tantalum	DN1C 4R7M1S
C8	Ceramic	0.001 50V
C9	Ceramic	5P 50V
C10	Ceramic	100P 50V
C11	Ceramic	39P 50V
C12	Barrier	0.01 25V
C13	Barrier	0.01 25V
C15	Ceramic	27P 50V
C17	Ceramic	39P 50V
C18	Ceramic	3P 50V
C19	Ceramic	47P 50V CH
C20	Ceramic	82P 50V CH
C21	Ceramic	12P 50V
C22	Ceramic	0.001 50V
C23	Ceramic	9P 50V
C24	Barrier	0.01 25V
C25	Ceramic	0.001 50V
C26	Barrier	0.01 25V
C27	Ceramic	0.001 50V
C29	Ceramic	1P 50V
C30	Ceramic	10P 50V
C31	Ceramic	0.35P 50V
C32	Ceramic	1P 50V
C33	Ceramic	10P 50V
C34	Ceramic	0.001 50V

RX UNIT

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	REF. NO.	DESCRIPTION	TYPE (PART NO.)			
C35	Ceramic	0.001	50V	C104	Electrolytic	1	50V	MS7
C36	Ceramic	0.001	50V	C106	Ceramic	0.001	50V	
C37	Ceramic	0.35P	50V	C108	Ceramic	56P	50V	
C38	Ceramic	1P	50V	C109	Ceramic	0.001	50V	
C39	Ceramic	10P	50V	C110	Electrolytic	4.7	25V	MS7
C42	Ceramic	0.001	50V	C111	Electrolytic	0.1	50V	MS7
C43	Ceramic	22P	50V	C112	Barrier	0.01	25V	
C44	Ceramic	22P	50V	C113	Electrolytic	10	16V	MS7
C45	Ceramic	470P	50V	C114	Electrolytic	0.33	50V	MS7
C46	Ceramic	0.001	50V	C115	Electrolytic	4.7	25V	MS7
C47	Ceramic	10P	50V	C116	Ceramic	0.001	50V	
C48	Ceramic	10P	50V	C117	Ceramic	470P	50V	
C49	Ceramic	0.001	50V	C118	Ceramic	0.001	50V	
C50	Ceramic	18P	50V	C119	Ceramic	0.001	50V	
C51	Ceramic	470P	50V	C120	Tantalum	DN1V	0R1M1S	
C52	Ceramic	22P	50V					
C53	Ceramic	22P	50V	J1	Connector	IMSA-9201B-2-02-T		
C54	Ceramic	0.001	50V	J2	Connector	IMP-J01X-A2		
C55	Ceramic	0.001	50V	J3	Connector	IMP-J01X-A2		
C56	Barrier	0.0015	25V	J4	Connector	B9B-EH-S		
C57	Ceramic	33P	50V	J5	Connector	B3B-EH-S		
C58	Barrier	0.0015	25V	J6	Connector	HSJ0836-001-010		
C59	Barrier	0.01	25V	J7	Connector	B6B-EH-S		
C61	Electrolytic	1	50V	MS7	J8	Connector	B9B-EH-S	
C62	Ceramic	100P	50V					
C63	Barrier	0.01	25V	S1	Switch	SPPH21127A		
C64	Barrier	0.01	25V					
C65	Barrier	0.01	25V	BT1	Lithium Battery	BR2032-1T2		
C66	Barrier	0.01	25V					
C67	Electrolytic	1	50V	MS7	EP1	P.C.B.	B-1196D	
C68	Electrolytic	10	16V	MS7	EP2	P.C.B.	B-1141B	
C69	Barrier	0.01	25V		EP3	Crystal Seat	41424	
C70	Ceramic	0.001	50V		EP4	Filter Spacer	41590	
C71	Ceramic	0.001	50V					
C72	Ceramic	0.001	50V		MP1	Helical Cavity	No.5	41053
C73	Electrolytic	1	50V	MS7	MP1	Helical Cavity	No.12	41053 (IC-28H version)
C74	Ceramic	0.001	50V		MP2	Helical Cavity	No.5	41053
C75	Electrolytic	10	16V	MS7	MP2	Helical Cavity	No.12	41053 (IC-28H version)
C76	Ceramic	0.001	50V		MP3	AF Amp Heat Sink	(1)-1	43313
C77	Ceramic	470P	50V					
C78	Electrolytic	0.1	50V	MS7	W1		JPW-02A	
C79	Electrolytic	47	16V	MS9	W2		JPW-02A	
C80	Electrolytic	220	16V	MS9	W3	JUMPER	74/98/015/X98/X98	
C81	Barrier	0.1	16V		W4		JPW-02A	
C82	Electrolytic	47	16V	MS9				
C83	Electrolytic	220	16V	MS9				
C84	Electrolytic	470	16V	MS16				
C85	Barrier	0.1	16V					
C86	Electrolytic	10	16V	MS7				
C87	Electrolytic	4.7	25V	MS7				
C88	Barrier	0.1	16V					
C89	Barrier	0.1	16V					
C90	Barrier	0.1	16V					
C92	Ceramic	0.001	50V					
C94	Ceramic	0.001	50V					
C95	Ceramic	0.001	50V					
C96	Barrier	0.01	25V					
C97	Barrier	0.01	25V					
C98	Electrolytic	10	16V	MS7				
C99	Barrier	0.01	25V					
C100	Barrier	0.01	25V					
C101	Barrier	0.0047	25V					
C102	Mylar	0.056	50V					
C103	Ceramic	0.001	50V					

MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	REF. NO.	DESCRIPTION	TYPE (PART NO.)			
R102	Resistor	220k	ELR20	C56	Electrolytic	10	16V	MS7
R103	Resistor	6.8k	ELR20	C57	Ceramic	0.001	50V	
R105	Resistor	100k	ELR20 (#01)	C58	Ceramic	0.001	50V	
R106	Resistor	180k	ELR20	C59	Ceramic	0.001	50V	
R107	Resistor	680	ELR20	C60	Ceramic	0.001	50V	
R108	Resistor	1.2M	ELR20	C61	Electrolytic	10	16V	MS7
R109	Resistor	47k	R20	C62	Ceramic	0.001	50V	
R110	Resistor	100k	R20	C64	Ceramic	0.001	50V	
R111	Resistor	470k	ELR20	C65	Ceramic	22P	500V	
R112	Resistor	10	R50X (IC-28H version)	C65	Ceramic	12P	500V	(IC-28H version)
R113	Resistor	150	ELR20 (IC-28H version)	C66	Ceramic	1P	50V	
				C66	Ceramic	2P	50V UJ	(IC-28H version)
C1	Tantalum	DN1V	100M1S	C67	Ceramic	20P	50V	
C2	Tantalum	DN1V	100M1S	C67	Ceramic	27P	50V CH	(IC-28H version)
C3	Tantalum	DN1V	2R2M1S	C68	Ceramic	1P	50V	
C4	Tantalum	DN1V	0R1M1S	C68	Ceramic	2P	50V UJ	(IC-28H version)
C5	Ceramic	470P	50V	C69	Ceramic	20P	50V	
C6	Ceramic	470P	50V	C69	Ceramic	27P	50V CH	(IC-28H version)
C7	Ceramic	0.001	50V	C70	Ceramic	12P	500V	
C9	Ceramic	1P	50V	C71	Ceramic	0.001	50V	
C10	Ceramic	0.001	50V	C72	Ceramic	0.001	50V	
C11	Ceramic	1P	50V	C73	Ceramic	0.001	500V	
C12	Ceramic	470P	50V	C74	Ceramic	100P	50V	
C13	Ceramic	100P	50V	C75	Ceramic	39P	50V	
C14	Ceramic	470P	50V	C76	Ceramic	15P	500V	
C15	Tantalum	DN1C	4R7M1S	C77	Ceramic	30P	500V	
C17	Electrolytic	3.3	50V MS7	C78	Ceramic	30P	500V	
C18	Electrolytic	3.3	50V MS7	C79	Ceramic	10P	500V	
C19	Ceramic	100P	50V	C80	Ceramic	220P	50V	
C20	Electrolytic	10	16V MS7	C81	Barrier	0.01	25V	
C21	Ceramic	470P	50V	C82	Ceramic	470P	50V	
C22	Ceramic	5P	50V	C83	Tantalum	DN1A	100M1S	
C23	Ceramic	10P	50V	C84	Barrier	0.01	25V	
C24	Ceramic	22P	50V	C85	Electrolytic	4.7	25V	MS7
C25	Ceramic	0.001	50V	C86	Ceramic	470P	50V	
C26	Ceramic	0.001	50V	C87	Tantalum	DN1V	R22M1S	
C27	Ceramic	0.001	50V	C88	Ceramic	470P	50V	
C28	Electrolytic	4.7	25V MS7	C89	Electrolytic	1	50V	MS7
C29	Ceramic	39P	50V	C90	Tantlum	DN1V	010M1S	
C30	Ceramic	27P	50V	C91	Barrier	0.01	25V	
C31	Trimmer	ECR-GA020E30	20P	C92	Ceramic	470P	50V	
C32	Barrier	0.1	16V	C93	Barrier	0.001	25V	
C33	Electrolytic	22	6.3V MS7	C94	Barrier	0.0022	25V	
C34	Ceramic	470P	50V	C95	Ceramic	120P	50V	
C35	Ceramic	470P	50V	C96	Ceramic	39P	50V	(#01)
C36	Ceramic	470P	50V	C97	Ceramic	39P	50V	(#01)
C37	Electrolytic	10	16V MS7	C98	Electrolytic	0.1	50V	MS7 (#01)
C38	Ceramic	470P	50V	C99	Barrier	0.01	25V	(#01)
C39	Electrolytic	4.7	25V MS7	C100	Ceramic	0.001	50V	(#01)
C40	Ceramic	470P	50V	C101	Electrolytic	2.2	50V	MS7 (#01)
C46	Ceramic	12P	50V	C102	Ceramic	0.001	50V	
C46	Ceramic	47P	50V (IC-28H version)	C103	Ceramic	0.001	50V	(IC-28A/E versions only)
C47	Ceramic	470P	50V					
C48	Ceramic	470P	50V	C104	Ceramic	470P	50V	
C49	Ceramic	470P	50V	C105	Electrolytic	47	25V	MS9
C50	Ceramic	470P	50V (IC-28A/E versions only)	C106	Ceramic	22P	500V	
C51	Ceramic	470P	50V (IC-28A/E versions only)	C106	Ceramic	18P	500V	(IC-28H version)
C52	Ceramic	22P	50V	C107	Ceramic	22P	50V	
C53	Ceramic	10P	50V (IC-28A/E versions only)	C108	Ceramic	22P	50V	
C54	Tantalum	DN1V	100M1S	C109	Ceramic	22P	50V	
C55	Ceramic	0.001	50V	C109	Ceramic	10P	50V	(IC-28H version)
				C110	Ceramic	22P	50V	
				C111	Ceramic	470P	50V	
				C112	Feed Through	TF318-450E	102GMV 50V	

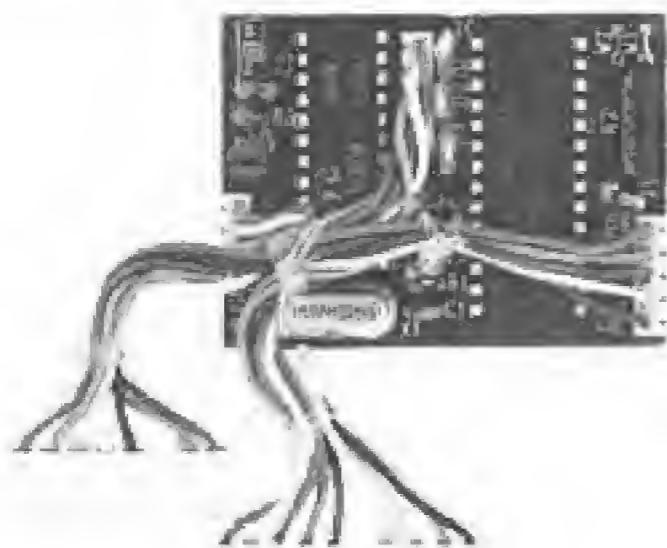
MAIN UNIT
11 - 3 RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	REF. NO.	DESCRIPTION	TYPE (PART NO.)	
C113	Ceramic	0.001	50V	IC1	IC	MC3357P
C114	Ceramic	20P	50V	IC2	IC	μPC1241H
C115	Ceramic	470P	50V	IC3	IC	MB3756
C115	Ceramic	2P	500V (IC-28H version)	IC4	IC	NJM4558D
C116	Ceramic	2P	500V (IC-28H version)	Q1	Transistor	2SC2668-O
C117	Ceramic	220P	50V (IC-28H version)	Q2	FET	2SK241-Y
C118	Ceramic	0.001	50V (IC-28H version)	Q3	FET	2SK125
J1	Connector	B03B-EH-S	Q4	Transistor	2SC3355	
J2	Connector	B04B-EH-S	Q5	Transistor	2SA1048-GR	
J3	Connector	B04B-EH-S (IC-28A/E versions only)	Q6	Transistor	2SC2458-GR	
J4	Connector	B10B-EH-S	Q7	Transistor	2SC2458-GR	
J5	Connector	B10B-EH-S	Q8	Transistor	2SC2458-GR	
J6	Connector	B08B-EH-S	Q9	Transistor	2SC2458-GR	
J7	Connector	TLB-P11H-B1	Q10	Transistor	2SA1348	
J8	Connector	B03B-EH-S	Q11	FET	2SJ105-GR	
J9	Connector	B07B-EH-S	Q12	Transistor	2SB909M-R	
J11	Connector	B04B-EH-S	Q13	Transistor	2SC2458-GR	
J12	Connector	B03B-EH-S (IC-28H version)	Q14	Transistor	2SC2458-GR	
J13	Connector	B04B-EH-S (IC-28H version)	Q16	Transistor	2SC3399	
			Q17	Transistor	2SC3399	
P1	Connector	TMP-P01X-A1	Q18	Transistor	2SA1048-GR	
P2	Connector	TMP-P01X-A1	Q19	Transistor	2SD1225M-R	
P3	Connector	EHR-09				
P4	Connector	EHR-03 (IC-28H version)	D1	Zener	RD6.2E B2	
EP1		OPC-90	D2	Varicap	1SV50E	
EP2		OPC-143	D3	Varicap	1SV50E	
EP3	P.C.B.	B-1136E	D4	Varicap	1SV50E	
EP3	P.C.B.	B-1250A (IC-28H version)	D5	Diode	1S953	
EP4	Ferrite Bead	DL2-OP2.6-3-1.2H	D6	Diode	1SS216	
EP5	Ferrite Bead	DL2-OP2.6-3-1.2H	D7	Diode	1SS216	
EP6	P.C.B.	B-1254 (IC-28H version)	D8	Diode	1SS216	
EP9	Crystal Seat	4124 (#01)	D9	Diode	1S953	
			D10	Diode	1S953	
			D12	Diode	1S953	
MP3	VCO Case	42550	D13	Diode	1S953	
MP4	VCO Case Cover	42551	D14	Diode	1S953	
MP10	Filter Shield Case	43246	D16	Diode	1SS133	
			D17	Diode	1SS133	
W2		61/08/140/C31/W13A	D19	Diode	1S953	
W3		61/99/170/C31/W13A P2	D20	Diode	1SS133	
W17		JPW-02A	D21	Diode	1SS133	
W22		JPW-02A	D22	Diode	1SS133	
			D24	Diode	R6.2E B2	
			D25	Diode	1SS133	
			D26	Diode	1SS133	
			D27	Diode	1SS133	
			FI1	Ceramic	CFV455E10	
			FI2	Crystal	17M15B	
			X1	Discriminator	CDB455C7A	
			X2	Crystal	CR166	
			L1	Coil	LS-66	
			L2	Coil	LS-66	
			L3	Coil	LS-171	
			L4	Coil	S4 101k	
			L5	Coil	LS-209	
			L6	Coil	LS-291	
			L7	Coil	LS-291	
			L8	Coil	LS-291	
			L9	Coil	LA-235	
			L10	Coil	LB-50A	

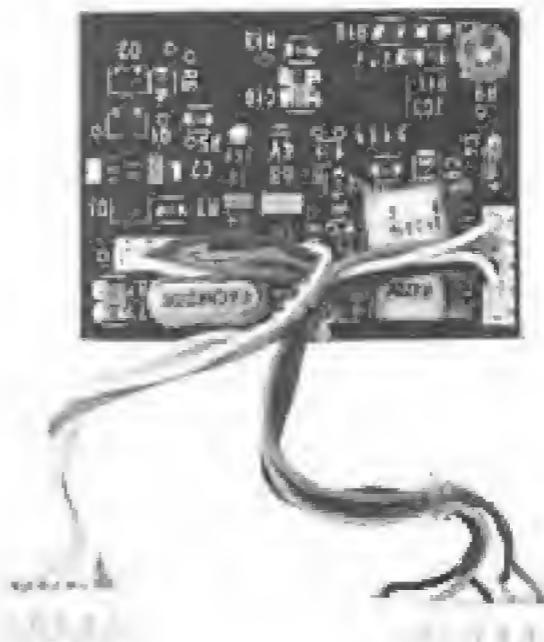
SECTION 12 OPTIONAL UNITS

12 - 1 UT-28, UT-29 OPTIONS

UT-28 DIGITAL CODE SQUELCH UNIT

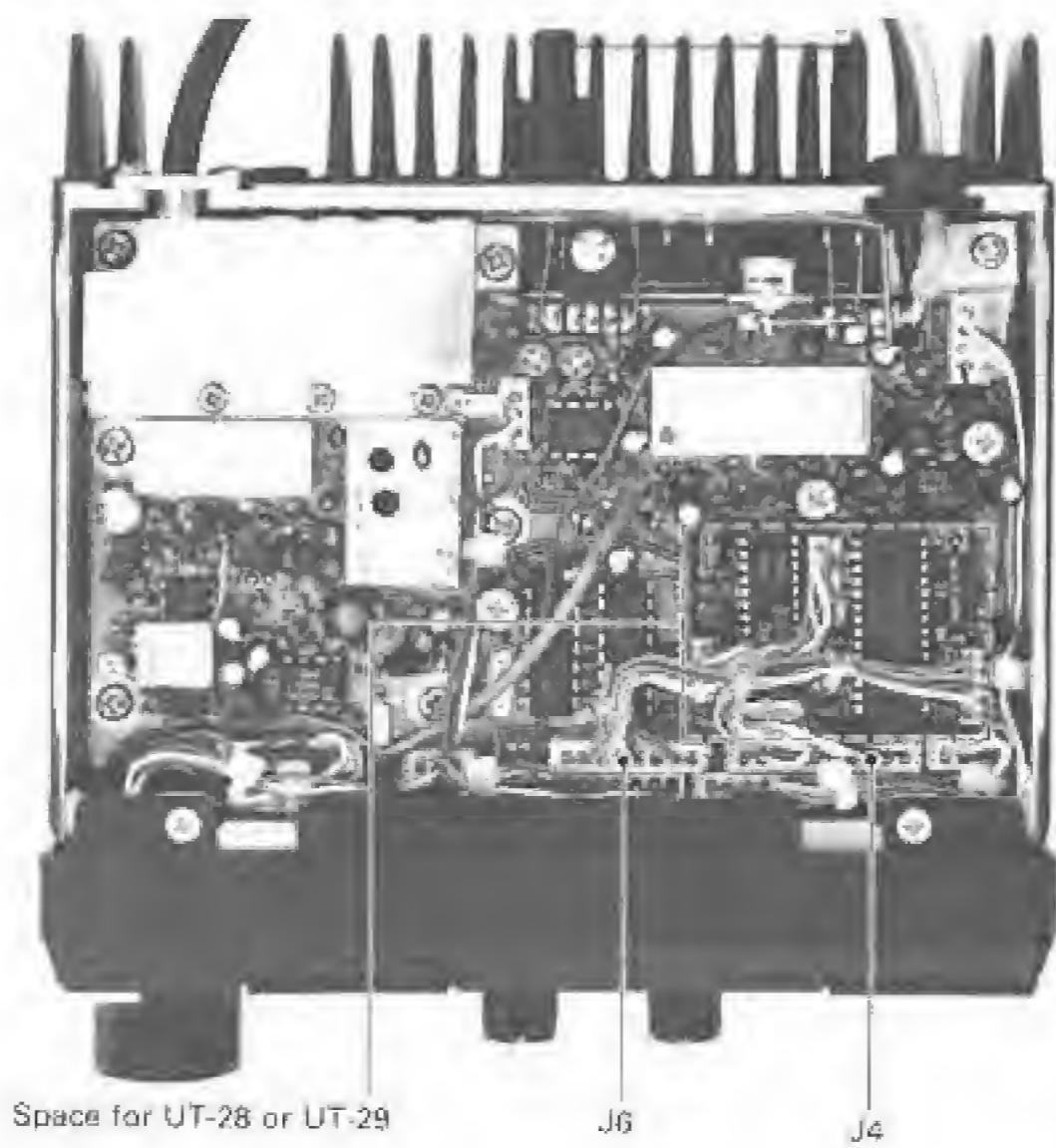


UT-29 TONE SQUELCH UNIT



INSTALLATION PROCEDURE

Installation location on MAIN UNIT for UT-28 and UT-29.

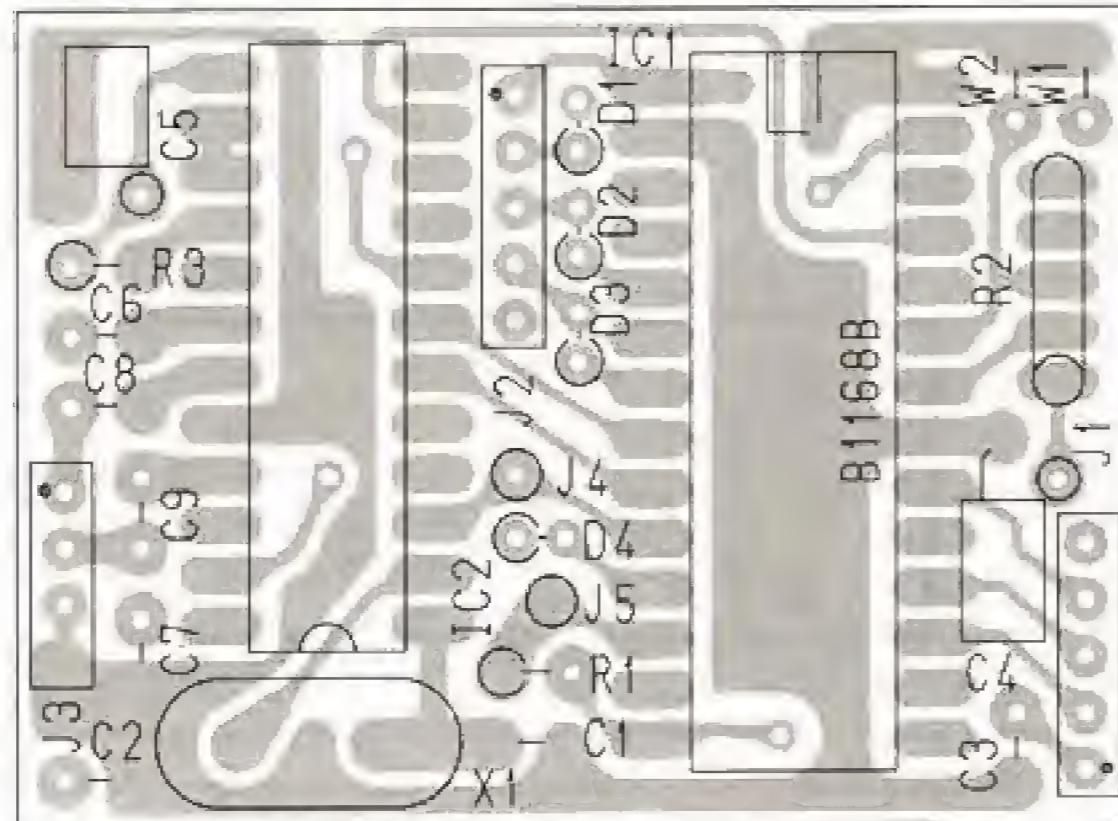


NOTE: Unplug the power cable before performing any work on the transceiver.

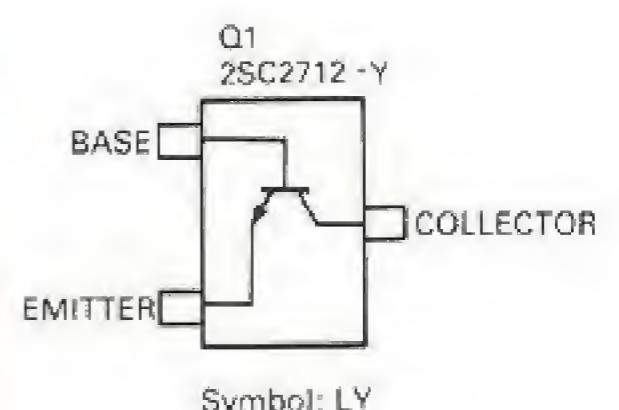
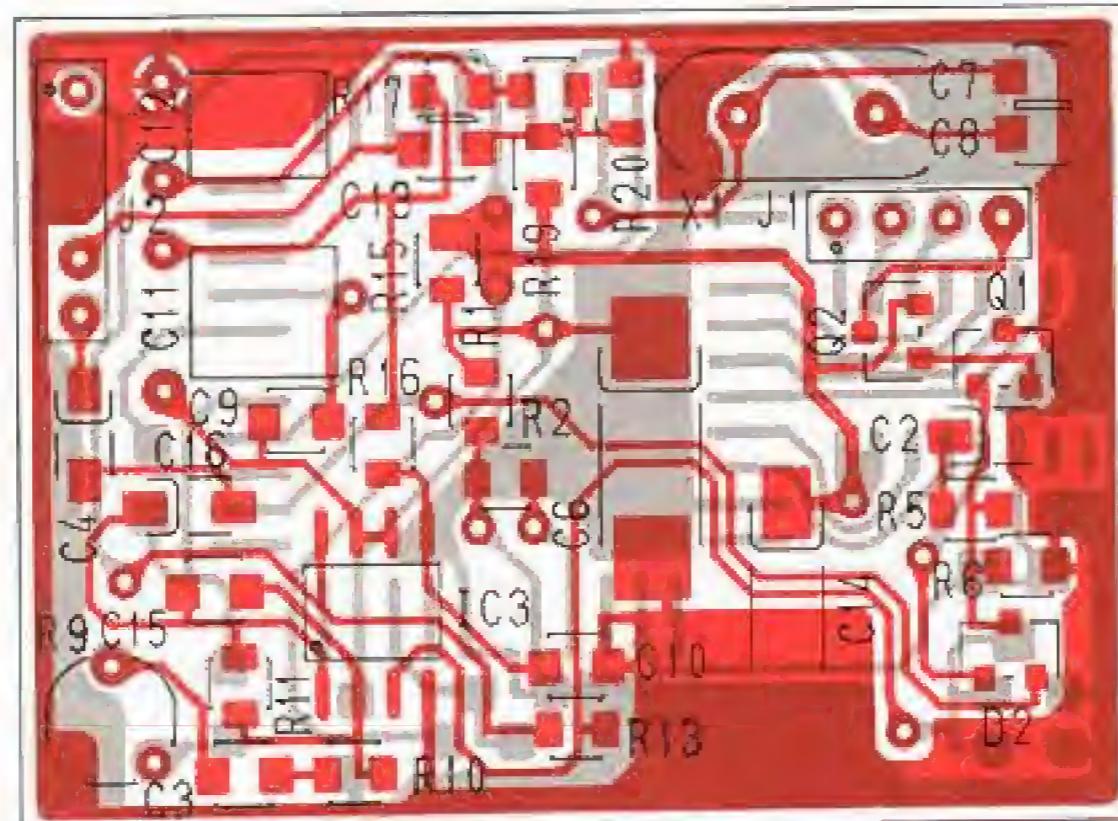
1. Unscrew the two cover screws on the rear panel and remove the top cover.
2. Connect the 10-pin and 8-pin plugs to J4 and J6 on the MAIN UNIT of the IC-28A/E/H.
3. Install the unit in the spot shown in the photo above.
 - Adhesive tape is applied to the sponge on the back of the unit, so remove this in order to install the unit properly.
4. Re-attach the cover to the transceiver.

12 - 2 UT-28, UT-29 BOARD LAYOUTS

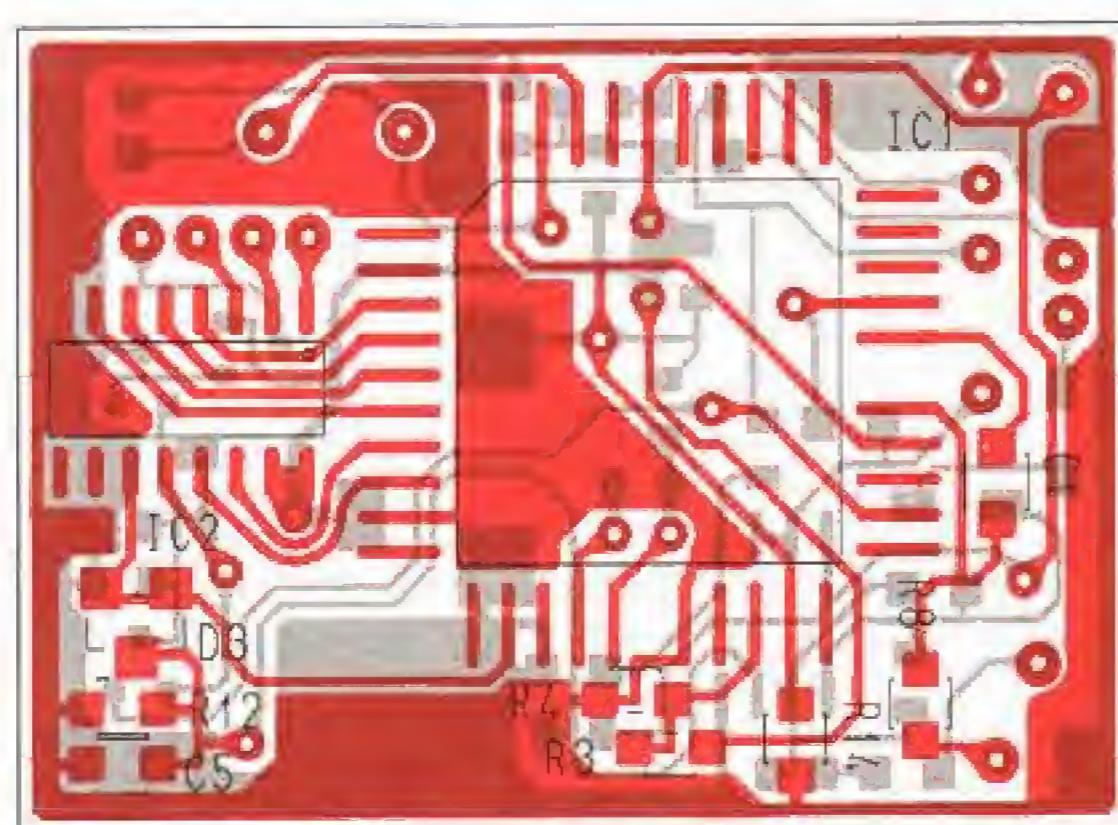
UT-28



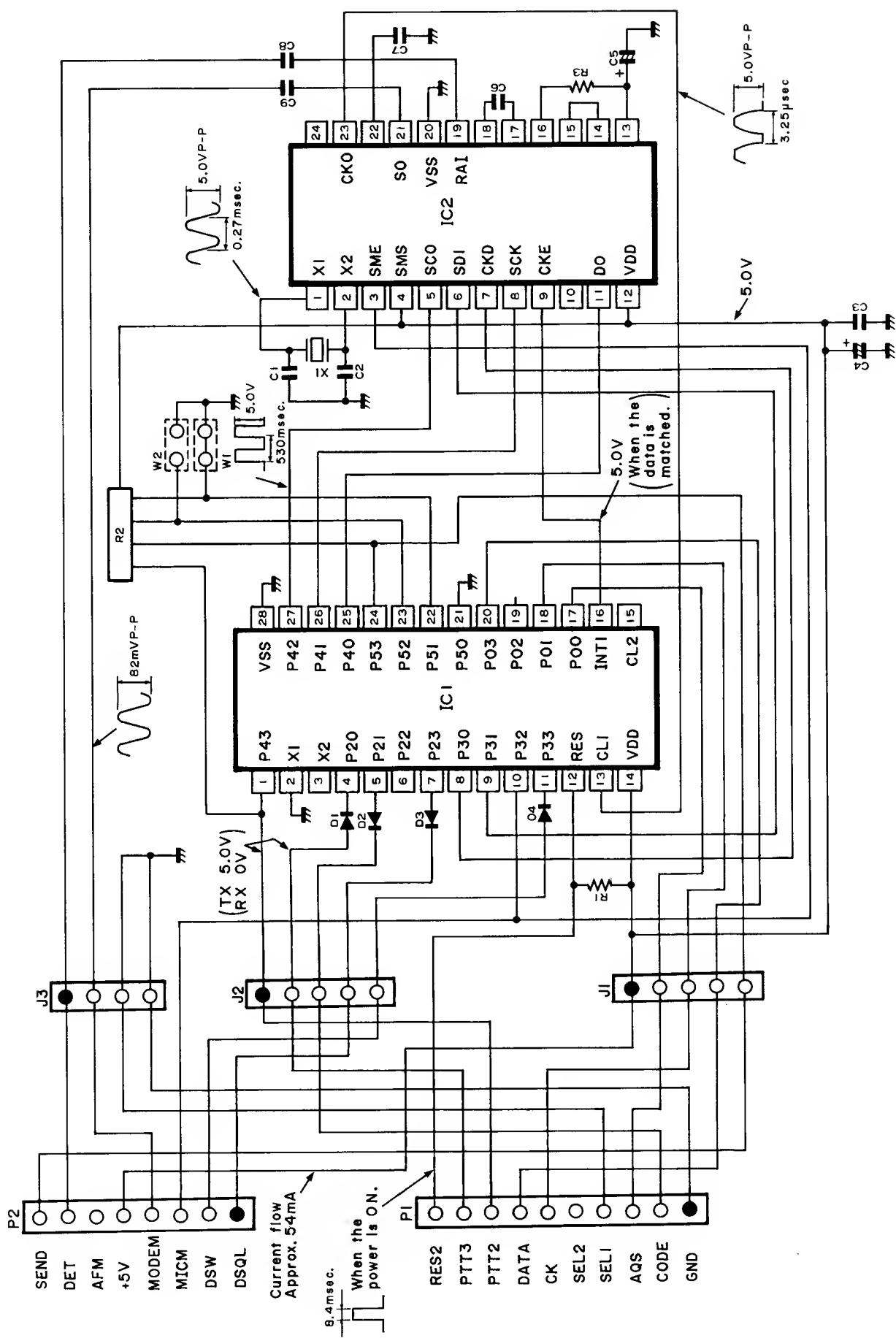
UT-29
(Top View)



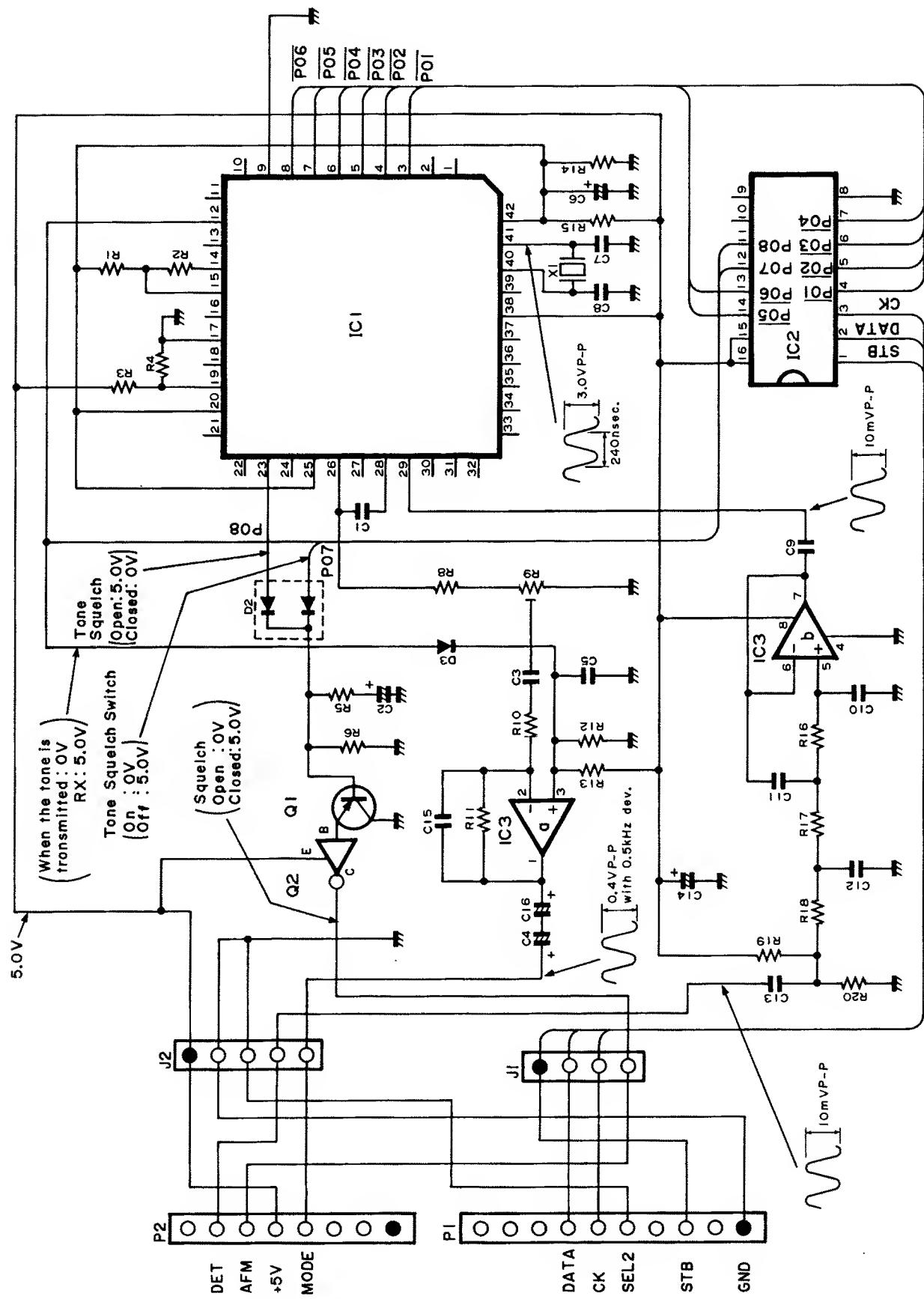
UT-29
(Bottom View)



12 - 3 UT-28 VOLTAGE/CIRCUIT DIAGRAM



12 - 4 UT-29 VOLTAGE/CIRCUIT DIAGRAM



12 - 5 UT-28, UT-29 PARTS LIST

UT-28 DIGITAL SQUELCH UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	REF. NO.	DESCRIPTION	TYPE (PART NO.)
IC1	IC	μPD7507SCT-217	IC1	IC	MN6520
IC2	IC	μPD6302CA	IC2	IC	μPD4094BG
			IC3	IC	NJM4558M
D1	Diode	1SS133			
D2	Diode	1SS133	Q1	Transistor	2SC2712-Y
D3	Diode	1SS133	Q2	Transistor	2SA1341
D4	Diode	1SS133			
			D2	Diode	1SS184
X1	Crystal	FABNKD00	D3	Diode	1SS193
			X1	Crystal	4.194304M FACNKDO0
R1	Resistor	27k ELR20			
R2	Array	RNSA05S473J	R1	Chip	2.2k MCR10
R3	Resistor	27k ELR20	R2	Chip	150k MCR10
C1	Ceramic	33P 50V	R3	Chip	10k MCR10
C2	Ceramic	33P 50V	R4	Chip	15k MCR10
C3	Monolithic	D33Y5V1E104Z21	R5	Chip	10k MCR10
C4	Electrolytic	4.7 25V MS5	R6	Chip	470k MCR10
C5	Electrolytic	4.7 25V MS5	R8	Chip	4.7k MCR10
C6	Barrier	0.01 25V	R9	Trimmer	10k RH0521C14J08A
C7	Monolithic	D33Y5V1E104Z21	R10	Chip	180k MCR10
C8	Monolithic	D33Y5V1E104Z21	R11	Chip	820k MCR10
C9	Monolithic	D33Y5V1E104Z21	R12	Chip	100k MCR10
			R13	Chip	100k MCR10
J1	Connector	PD09-05M	R14	Chip	10k MCR10
J2	Connector	PD09-05M	R15	Chip	10k MCR10
J3	Connector	PD09-04M	R16	Chip	330k MCR10
			R17	Chip	330k MCR10
P1	Connector	EHR-10	R18	Chip	330k MCR10
P2	Connector	EHR-08	R19	Chip	1M MCR10
			R20	Chip	1M MCR10
EP1	P.C.B.	B-1168A	C1	Monolithic	0.1 GRM40 F
			C2	Tantalum	1μ SVA1C105M
			C3	Monolithic	0.1 GRM40 F
			C4	Tantalum	1μ SVA1C105M
			C5	Monolithic	0.1 GRM40 F
			C6	Tantalum	68μ SVD0G686M
			C7	Monolithic	18P GRM40
			C8	Monolithic	18P GRM40
			C9	Monolithic	0.1 GRM40 F
			C10	Monolithic	82P GRM40
			C11	Mylar	0.039 50V
			C12	Mylar	0.0047 50V
			C13	Monolithic	0.1 GRM40 F
			C14	Tantalum	10μ SVC1C106M
			C15	Monolithic	270P GRM40
			C16	Tantalum	1μ SVA1C105M
			J1	Connector	PD09A-04M
			J2	Connector	PD09A-05M
			P1	Connector	EHR-10
			P2	Connector	EHR-08
			EP1	P.C.B.	B-1197A

12 - 6 OTHER OPTIONAL UNITS

Part of the tremendous versatility in the IC-28A/E/H is its adaptability to base station use when not being used as a mobile unit.

The following recommended options will help complement your new base station system.

PS-45 POWER SUPPLY
(For use with the IC-28A/E)



The OPC-102 INTERFACE CABLE for connecting the PC-45 to the IC-28A/E must be purchased separately.

IC-PS30 AC POWER SUPPLY
(For use with the IC-28H)



SP-7 EXTERNAL SPEAKER

- Compact, easily installed in a variety of locations
- Adjustable, light-weight stand



SP-10 EXTERNAL SPEAKER

- Adjustable stand for multi-directional audio output
- Excellent also for mobile use



SM-8 DESK MICROPHONE

- Electret condenser type mic element
- UP/DOWN function switches
- Tone control
- HIGH/LOW mic output selectability



SM-10 COMPRESSOR/GRAFIC EQUALIZER DESK TOP MICROPHONE

- Electret condenser mic element
- Compressor amplifier
- Tunable equalizer
- Level meter and Output level control
- UP/DOWN function switches



AND FOR MOBILE USE:

HS-15 MOBILE FLEXIBLE MICROPHONE

- Uni-directional mic
- Flexible neck
- Light, convenient for driving ease



HS-15SB SWITCHBOX

- Connects to the HS-15

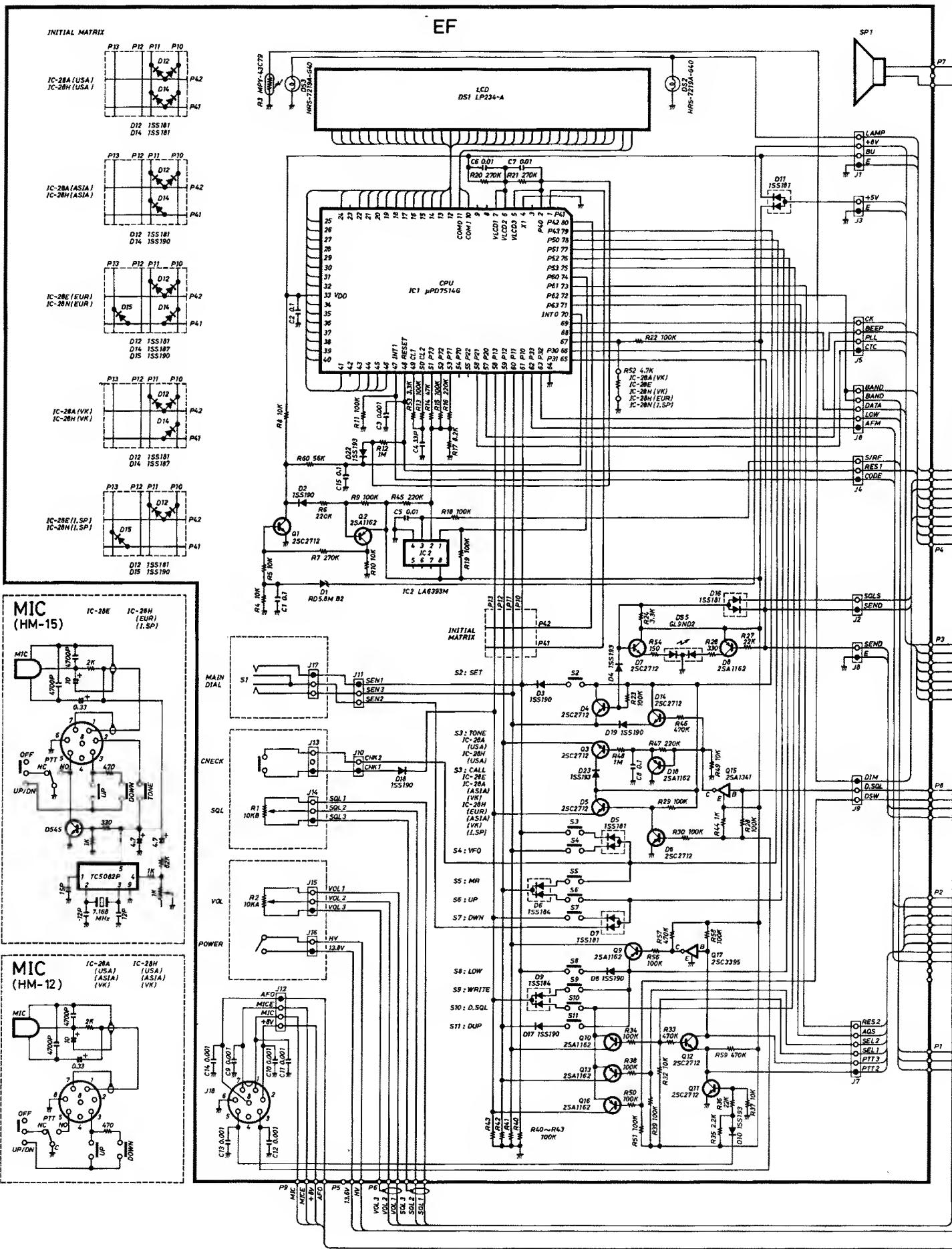


SP-8 EXTERNAL MOBILE SPEAKER

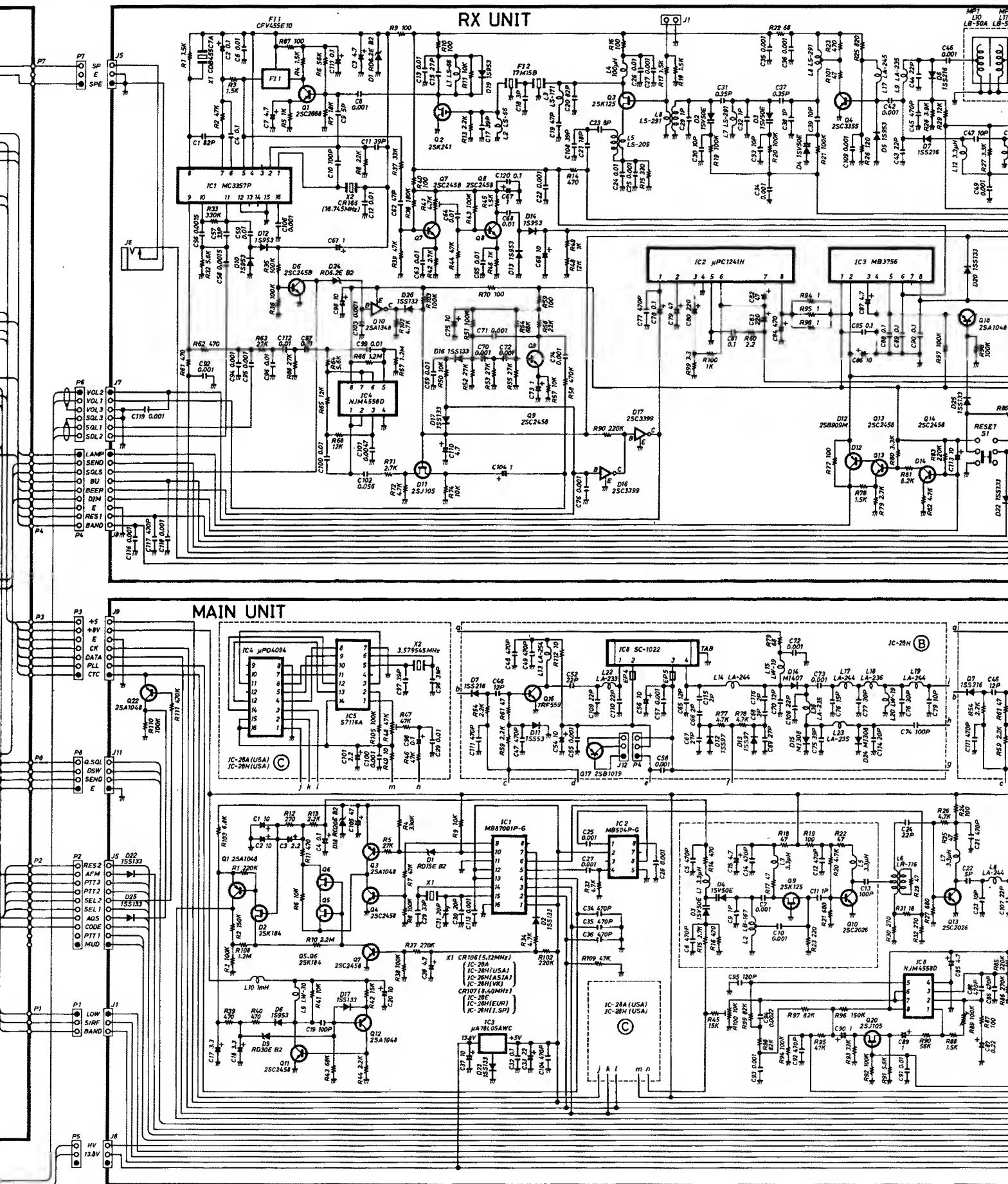
- Compact, easily attachable to your sun visor or dashboard



IC-28A/E/H SCHEMATIC DIAG

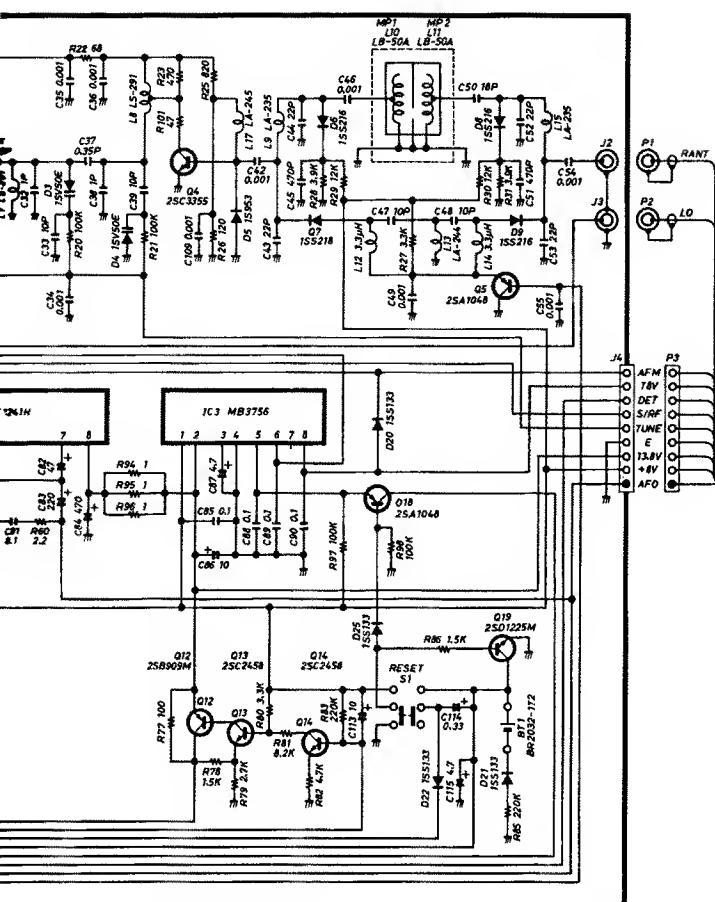


DIAGRAM



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